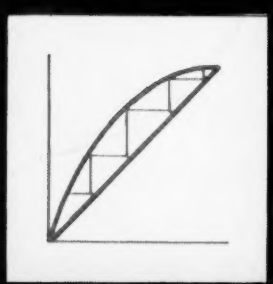
Chemical Engineering

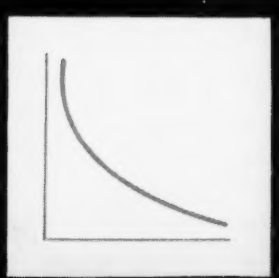
HOW TO MAKE
Butadiene
PAGE 306

SEPTEMBER 1954

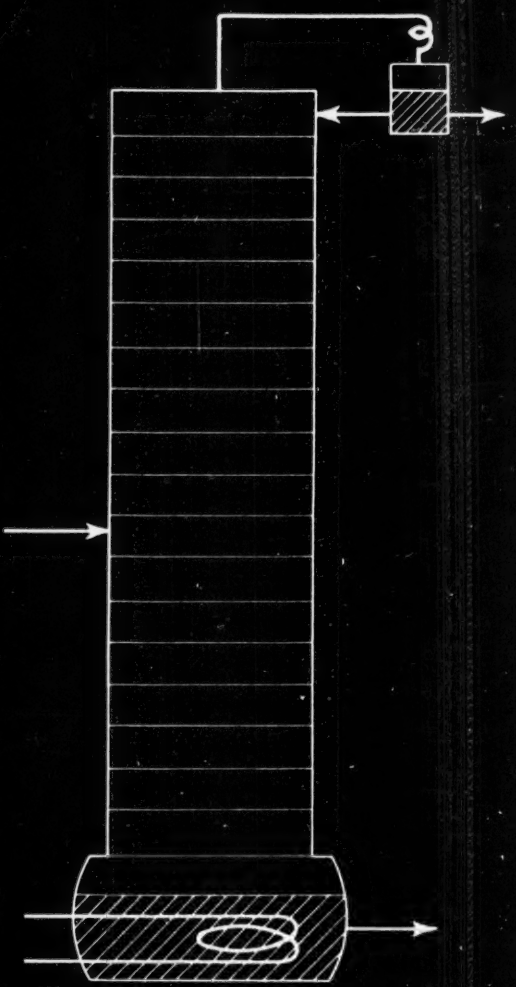
Vapor-Liquid Equilibrium Relationships

Fractionation Theory





Equipment Design & Performance



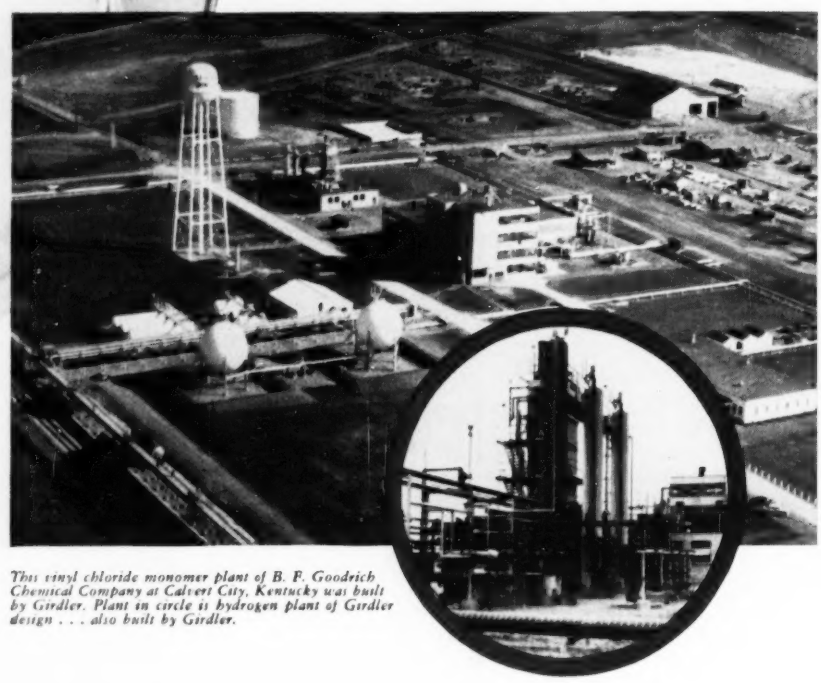
BINARY DISTILLATION

A CE REFRESHER REPORT

A McGRAW-HILL PUBLICATION

ONE DOLLAR

THIS IS GIRDLER



This vinyl chloride monomer plant of B. F. Goodrich Chemical Company at Calvert City, Kentucky was built by Girdler. Plant in circle is hydrogen plant of Girdler design . . . also built by Girdler.

Another Chemical Plant built by Girdler

HERE IS FURTHER EVIDENCE of continuing confidence placed in Girdler service. This is the fifth major project to be completed for B. F. Goodrich Chemical Company by Girdler. Starting with Goodrich's basic process data, Girdler engineered and built this vinyl chloride monomer plant. Included is a hydrogen plant of Girdler design and construction. Efficient *coordination* of all project phases and *centralized responsibility* by Girdler saves valuable time. If you are planning an expansion or new facility, call Girdler . . . and profit from this *complete service.*

GIRDLER DESIGNS processes and plants

GIRDLER BUILDS processing plants

GIRDLER MANUFACTURES processing apparatus

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Wood Bonding	Plastic Preform Preheating

The **GIRDLER** Company

A DIVISION OF NATIONAL CYLINDER GAS COMPANY

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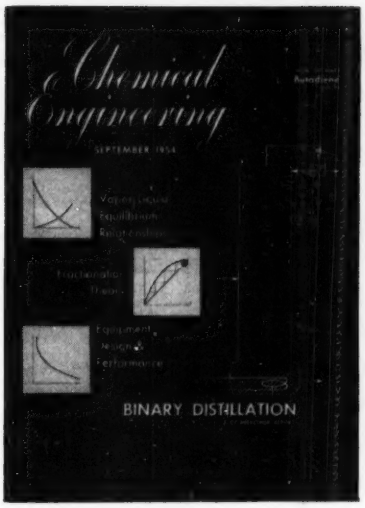
In Canada: Girdler Corporation of Canada Limited, Toronto
VOTATOR DIVISION: New York, Atlanta, Chicago, San Francisco

GUIDED TOUR

JOHN R. CALLAHAM, EDITOR



For Your Files

For a year we've worked hard to make it easier for you to file CE's articles and departments.

By developing a new format, by changing layout and by shifting page and article positions, we've been able to show these gains:

- Over 90% of all feature articles can now be clipped without destroying any adjacent reference material; last year's figure was 30%.
- All feature departments (such as Plant Notebook, Refresher, You & Your Job) can be clipped without damaging any other editorial at all.
- Most feature departments can be filed with no more than 35% of the ad pages formerly necessary.
- All items within feature departments can be clipped without any damage to back-up editorial; this was seldom possible in the past.
- The practice of "jumping" or continuing a feature article on widely separated pages has been dropped.

These changes have the hearty approval of the vast majority of our 38,500 subscribers—JRC

. . . This month's special: A roundup refresher on binary distillation.

In this issue's 21-page report, Aaron Teller reviews the fundamentals of two-component systems, then shows how to apply the more advanced principles and techniques. He covers vapor-liquid equilibria, how to apply principles of fractionation to basic problems in column design, the practical aspects of equipment design and performance. (p. 168)

Pick valves to combat corrosion.

Here are answers to the 75 questions most often asked by chemical engineers on valves and how to select them. They cover problems on corrosion, materials, installation, operation and repair. (p. 198)

How to shortcut with statistics.

It's easy, say Frank Proschan and Bud Babcock, if you don't bog down with theory. They prove it in this article

Please turn page

GUIDED TOUR

and show how statistics can solve engineering problems quickly. (p. 193)

Quick look at selective adsorption.

What's the trend in this up-and-coming fractional separation technique? What's ahead in continuous countercurrent operations? Here's a quick review of the present —and a squint at the future. (p. 189)

Flow meter with a 100: 1 range.

DuPont's Al McKinney comes up with a smart way to make a control valve serve as a flow meter measuring over a range of 100 to 1, shows exactly how to do it. It's a Plant Notebook prize winner. (p. 222)

Heard the latest in new equipment?

About one firm's brand new line of "off-the-shelf" pumps with custom-built features? Or about scores of other developments, all designed to help you do a better job? PEN covers the whole field. (p. 268)

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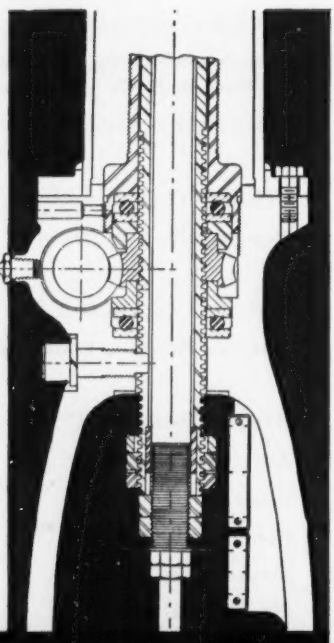
The Beauty of Functional Design

IN THE **HAMMEL-DAHL**

CONTINUOUSLY CONNECTED HANDWHEEL...

Achieved by integrating parts in the ***compact, completely enclosed*** gear housing illustrated below.

- STRAIGHT-LINE LIFT—No side thrust is exerted against the valve stem.
- COMPLETELY UNHAMPERED AUTOMATIC OPERATION—Permits limiting of valve lift if desired—but in the neutral position the handwheel mechanism offers *no resistance* to valve stem movement.
- INITIAL LUBRICATION LASTS INDEFINITELY.



COMPLETE Information in Bulletin 109-A

HAMMEL-DAHL COMPANY

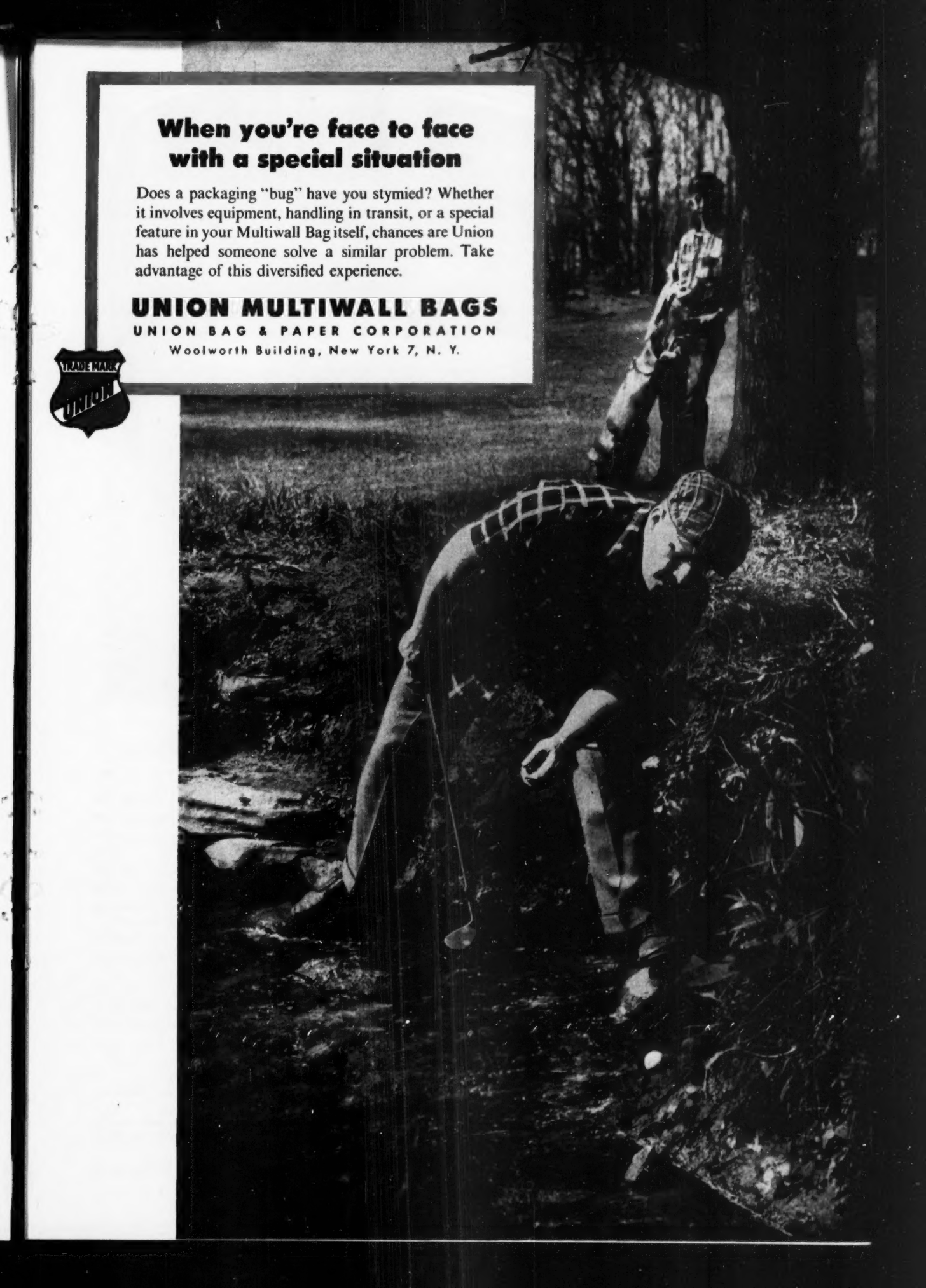
(H)---(D) 175 POST ROAD, (WARWICK) PROVIDENCE 5, R. I., U. S. A. (H)---(D)

SALES OFFICES IN ALL PRINCIPAL CITIES

MANUFACTURING PLANTS IN WARWICK, R. I., U. S. A., CANADA, ENGLAND, FRANCE AND HOLLAND

CANADIAN MANUFACTURING AFFILIATE—GUELPH ENGINEERING CO., GUELPH, ONT.

VISIT OUR BOOTH 410-412, FIRST INTERNATIONAL INSTRUMENT EXHIBIT—PHILADELPHIA, SEPTEMBER 13 THRU 24


When you're face to face
with a special situation
Does a packaging "bug" have you stymied? Whether it involves equipment, handling in transit, or a special feature in your Multiwall Bag itself, chances are Union has helped someone solve a similar problem. Take advantage of this diversified experience.
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UNION BAG & PAPER CORPORATION
Woolworth Building, New York 7, N. Y.
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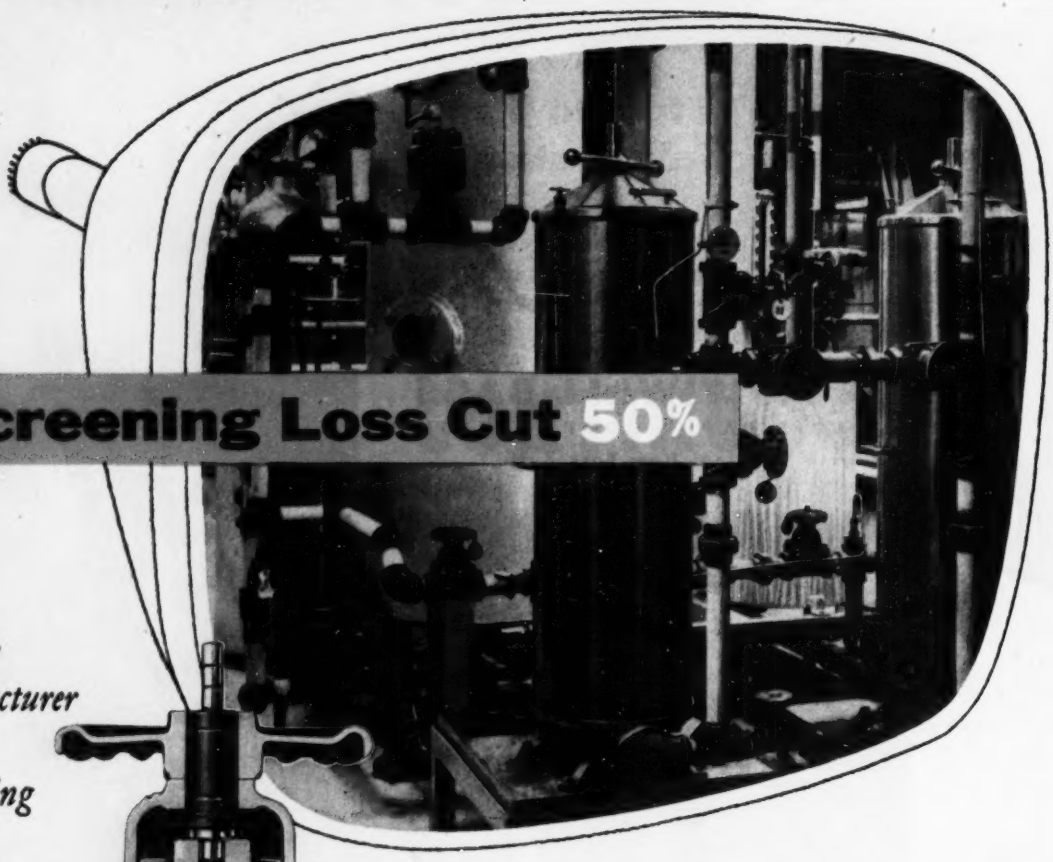
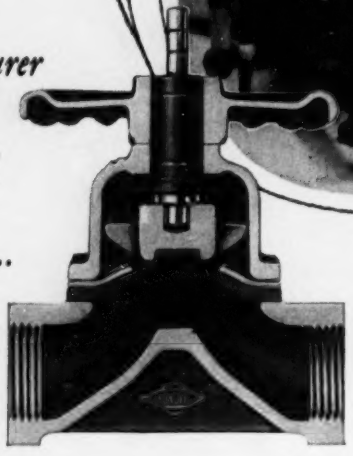


Screening Loss Cut 50%

TV tube manufacturer reports big saving after installing...

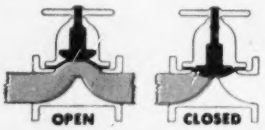


Grinnell-Saunders Diaphragm Valves

Radio Valve of Toronto faces this problem. In making its TV tubes, large quantities of the purest water possible are needed. Obliged to use regular city water, Radio Valve's first job is to filter this water to make it sterile and free of minerals. Next, 2 or 3 gallons are introduced into each TV tube. A fluorescent powder is added, which is allowed to settle on the screen. After decanting the water, screens are checked for flaws. Obviously, impurities in the water mean flaws in the screen, and a loss of time and money.

Since the installation of Grinnell-Saunders Diaphragm Valves, this user reports screening losses cut in half! Contamination of the purified water is eliminated, because the water passing through the valve is completely isolated from the valve mechanism. Of the Grinnell valves in this service, approximately 90% are stainless steel.

With the Grinnell-Saunders valve, the flexible diaphragm lifts high for streamline flow, in either direction; closure is positive against pressure or vacuum. There are no packing glands to demand attention; no metal-to-metal seats to become damaged or wire-drawn; no refacing or reseating. Body, lining and diaphragm materials are available to meet different service conditions. Write for full details.



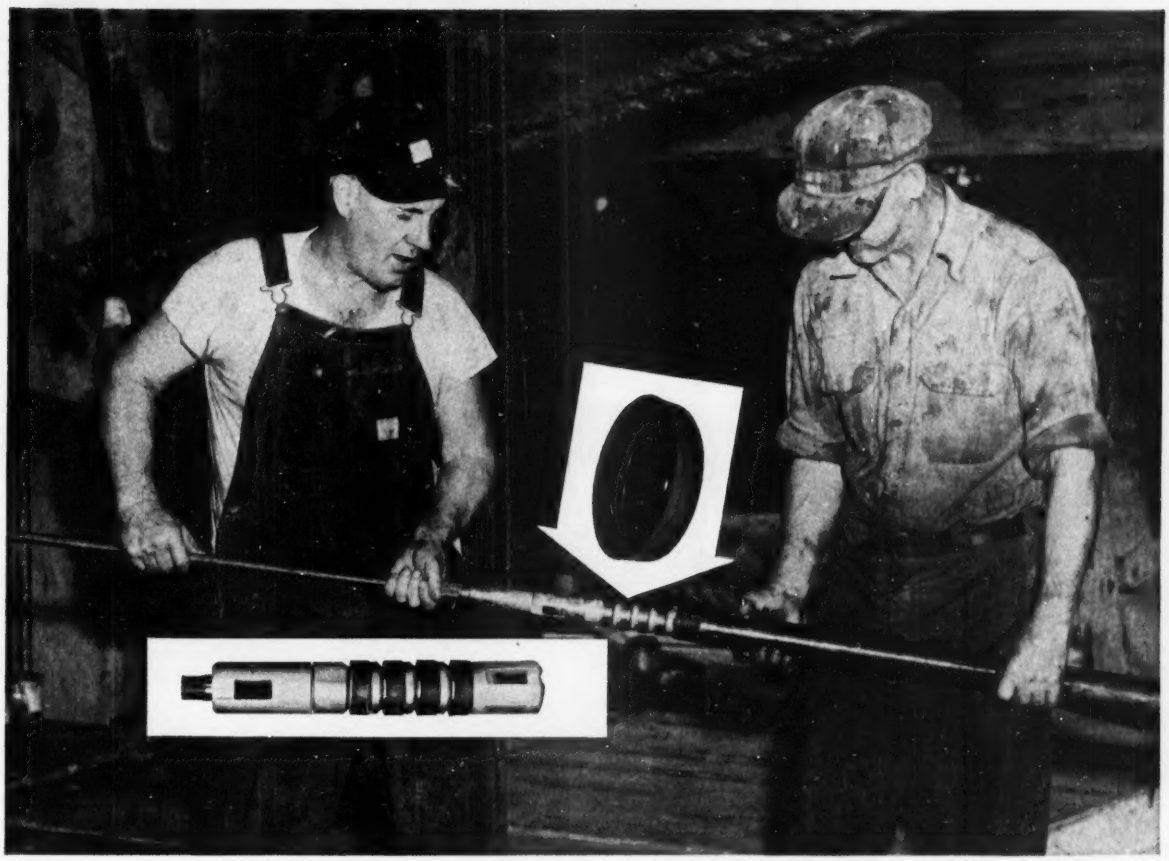
GRINNELL
WHENEVER PIPING IS INVOLVED

Grinnell Company, Inc., Providence, Rhode Island • Coast-to-Coast Network of Branch Warehouses and Distributors

pipe and tube fittings • welding fittings • engineered pipe hangers and supports • Thermolier unit heaters • valves Grinnell-Saunders diaphragm valves • pipe • prefabricated piping • plumbing and heating specialties • water works supplies industrial supplies • Grinnell automatic sprinkler fire protection systems • Amco air conditioning systems

Another new development using

B. F. Goodrich Chemical *raw materials*



The pump rod cups are made by The Dragon Manufacturing Company, Marietta, Ohio. B. F. Goodrich Chemical Company supplies only the Hycar rubber.

IT'S HYCAR-PHENOLICS FOR TOUGHER, LONGER LASTING PARTS

HERE'S a combination that can handle the *really tough* jobs—Hycar American rubber and phenolic resins. The oil well pump rod cups pictured above are molded from a Hycar-phenolic blend. They maintain high pump efficiency long after other cups would fail—extend the continuous operation of the pumps by as much as three months. Result—users gain higher well production and lower labor costs.

This outstanding performance is made possible by combining Hycar with a phenolic resin. The result is a compound with better shock, abrasion and fatigue resistance than ordinary rigid materials. Furthermore, Hycar-phenolics resist the deteriorating effects of oil and many chemicals and, because of their excellent processing characteristics, frequently solve the problem of molding intricate parts.

Hycar, either alone or in combination with other materials, may help you develop products that will stand up under severe conditions. For technical information, please write Dept. GE-9, B. F. Goodrich Chemical Company, Rose Building, Cleveland 15, Ohio. Cable address: Goodchemco. In Canada: Kitchener, Ontario.

B. F. Goodrich Chemical Company
A Division of The B. F. Goodrich Company

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GEON polyvinyl materials • HYCAR American rubber • GOOD-RITE chemicals and plasticizers • HARMON colors

4027 stock items

You can plan for economical, efficient butt-welded corrosion piping with assurance of quick availability of *FLOWLINE* Fittings. Delivery can be made from stock by leading distributors. Made in sizes ½" through 12" — Schedules 5S, 10S, 40S, 80S — Stainless Types 304, 304L, 316, 347; Monel, Nickel, Aluminum. *Seamless fittings with all the plus values . . . at no extra cost.*

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NEW CASTLE, PENNSYLVANIA

World's Largest Manufacturer of Stainless Welding Fittings

Remember **FLOWLINE®** WELDING FITTINGS

Forget CORROSION PIPING PROBLEMS

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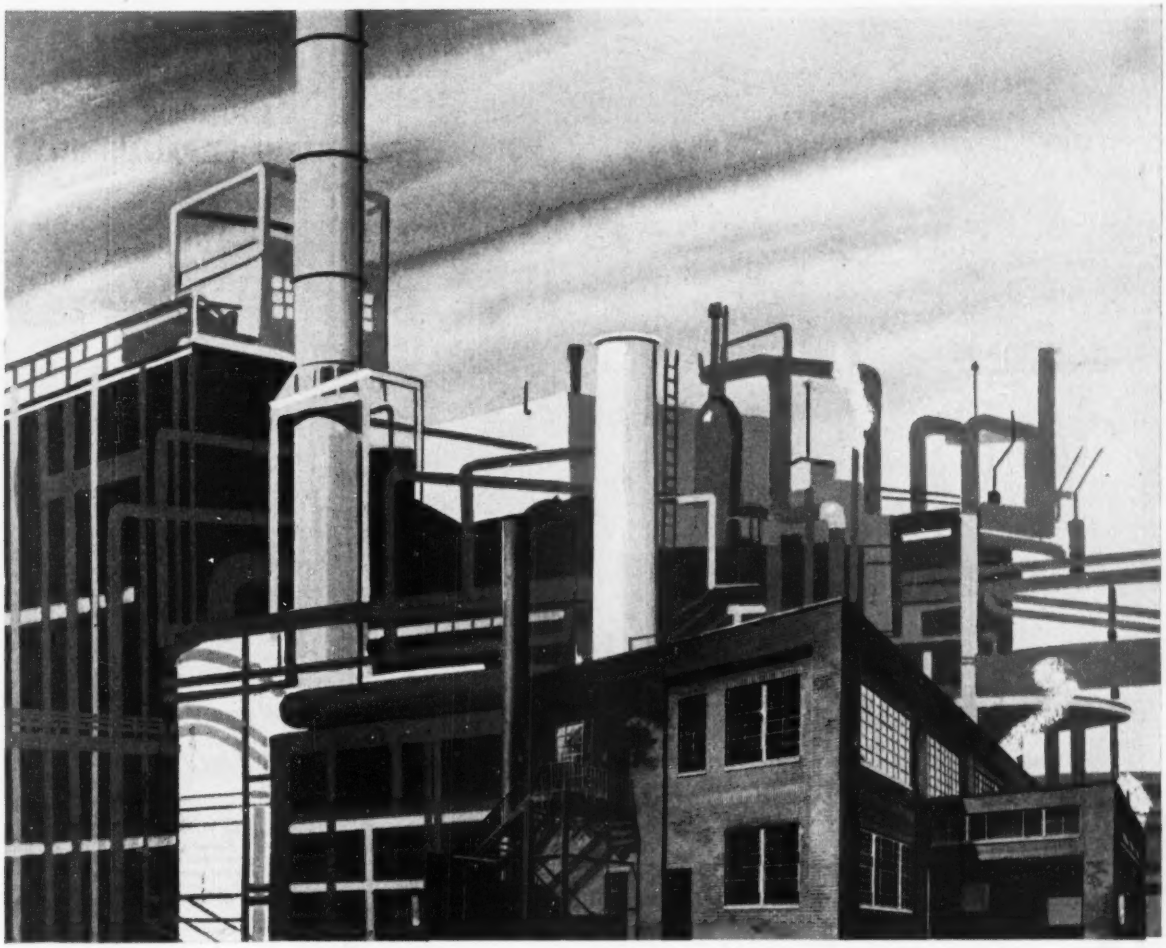


HERE'S A TEST PLANT THAT MAYBE YOU DIDN'T KNOW YOU HAD

It's a completely equipped, expertly staffed pilot scale laboratory devoted exclusively to the solving of solids-liquids separation problems.

It's already set up for you, to handle the running tests you'd make yourself if the complete facilities were right handy.

It gives you the facts and findings, quickly, confidentially and without restriction or prejudice, because tests are not limited to a single separation method or a single type of equipment. Bird builds, and can therefore make running tests on the widest range of equipment —

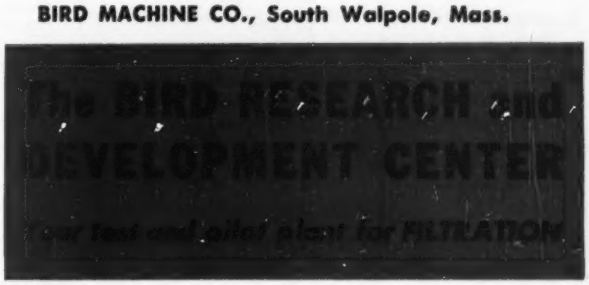
Continuous Centrifugal Solid Bowl Filters
Continuous Centrifugal Screen Filters
Continuous Vacuum Filters
Pressure Leaf Filters
Continuous Centrifugal Classifiers
Suspended Centrifugal Filters and Classifiers

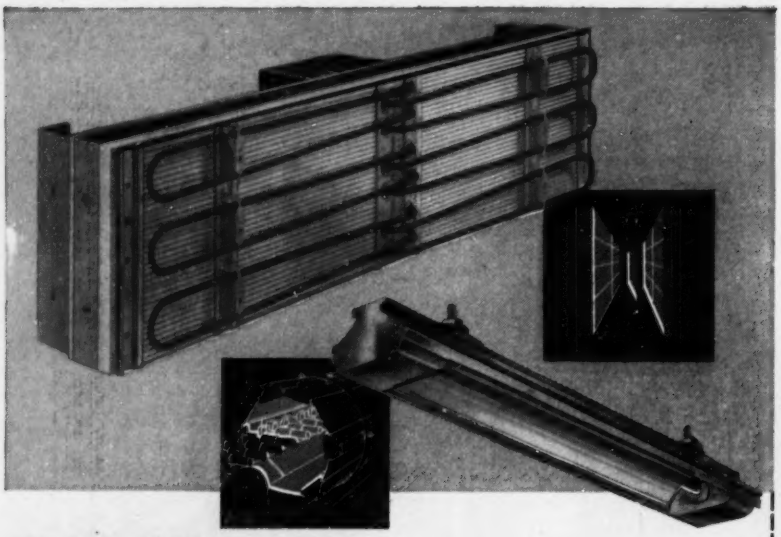
It's a test resource that gets you the facts on separating efficiency and economy *before* you make an equipment investment — not after!

It gives you a golden opportunity to check your present filtering, clarifying or classifying operations and see if they're as effective and economical as they should be.

This plant is YOURS TO USE. Are you taking advantage of it?

BIRD MACHINE CO., South Walpole, Mass.



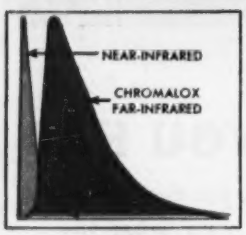


CHROMALOX *Far-infrared*

solves hundreds of heating problems

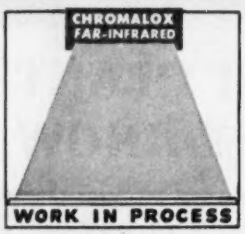
Here's your quick, economical and easy solution for curing, drying, degreasing, dehydrating, baking and other heating jobs. Pre-engineered Chromalox Units make oven building as simple as A-B-C, generate uniformly absorbed far-infrared heat for a multiplicity of processing needs. Temperatures up to 700° F. are easily selected, accurately maintained. Low initial cost, low write-off cost, low operating cost!

ONLY CHROMALOX GIVES YOU ALL THESE ADVANTAGES



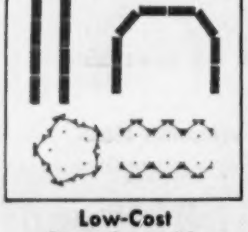
Color Blind Radiation

Longer far-infrared wave lengths are absorbed efficiently by all colors and textures.



Heat Without Hot or Cold Spots

Chromalox radiant energy goes to work in a uniform pattern to span widest conveyor.



Low-Cost Oven Assembly

Pre-engineered Chromalox units require minimum expense to erect into complete ovens.

Infinitely Variable Heat Output

Heat from 0 to 100% of capacity to fit the exact temperature needs of the work.

plus

- **SHATTERPROOF CONSTRUCTION**—nothing to break or contaminate the work in process.
- **NON-DIMINISHING OUTPUT**—with all-metal Chromalox tubular far-infrared generators.
- **HIGH INTENSITY RADIATION**—with top BTUs per square foot.
- **QUICK HEAT-UP**—with energy transformed instantly into heat on the work.
- **ADDITIONALLY SAFE**-for any work involving volatiles.
- **MINIMUM MAINTENANCE**—Because of metal-sheathed, shock-resistant, long-lasting Chromalox tubular generators.

CHROMALOX *Electric Heat*
FOR MODERN INDUSTRY

DATA SHEETS

available to you on

APPLICATIONS OF CHROMALOX RADIANT HEAT

ABRASIVES
- ☐ R-111: Drying Silicon Carbide Discs
- ☐ R-122: Drying Abrasive Cloth

ASPHALT
- ☐ L-1055: Melting Korite Sealing Compound
- ☐ R-105: Heating Asphalt to Improve Sealing of Batteries
- ☐ RP-203: Drying Asphalt Tile

AUTOMOTIVE
- ☐ R-126: Drying Tractor Parts
- ☐ R-118: Baking Synthetic Enamel on Gasoline Engines
  Also see: Paint Baking

BATTERY
- ☐ R-105: Heating Asphalt to Improve Sealing of Batteries

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- ☐ L-1065: Improves Enamel Baking Five Ways
- ☐ L-1066: Bakes Big Parts or Small, Fast or Slow
- ☐ L-1080: Baking Paint on Radiators
- ☐ R-118: Baking Synthetic Enamel on Gasoline Engines
- ☐ R-119: Baking Paint on Metal Awnings
- ☐ R-131: Baking Paint on Meter Parts
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- ☐ R-104: Preheating Micarta Strips for Punching
- ☐ R-121: Dehydrating Vinyl Sheets
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- ☐ R-132: Embossing Vinyl
- ☐ RP-210: Heating Plexiglas for Vacuum Forming
- ☐ RP-202: Heating Thermoplastic for Vacuum Forming

PRINTING
- ☐ L-1090: Silk Screen Process Drying
- ☐ R-103: Static Removal
- ☐ R-107: Drying Ink on a Miehle Vertical Press
- ☐ R-108: Ink Drying on 8-Unit Web-Fed Offset Press
- ☐ R-110: Eliminating "Offset" on Duplicating Machines
- ☐ R-124: Drying Ink on a Goss Press
- ☐ R-136: Silk Screen Process Drying

REFRIGERATION
- ☐ L-1055: Dehydrating Refrigerator Coils

RESTAURANT
- ☐ Far-Infrared Food Warmer

RUBBER
- ☐ L-1056: Curing Latex Foam Sponge Rubber
- ☐ R-125: Cementing Crepe Rubber to Wooden Soles

TEXTILES
- ☐ L-1068: Fusing Vinyl to Cloth Work Gloves
- ☐ R-112: Dehydrating Braiding Material

EDWIN L. WIEGAND CO., Radiant Heating Div.
7514 Thomas Blvd., Pittsburgh 8, Pa.

☐ Send me application reports I have checked.
☐ Have a Chromalox Application Engineer get in touch with me.

Name_____
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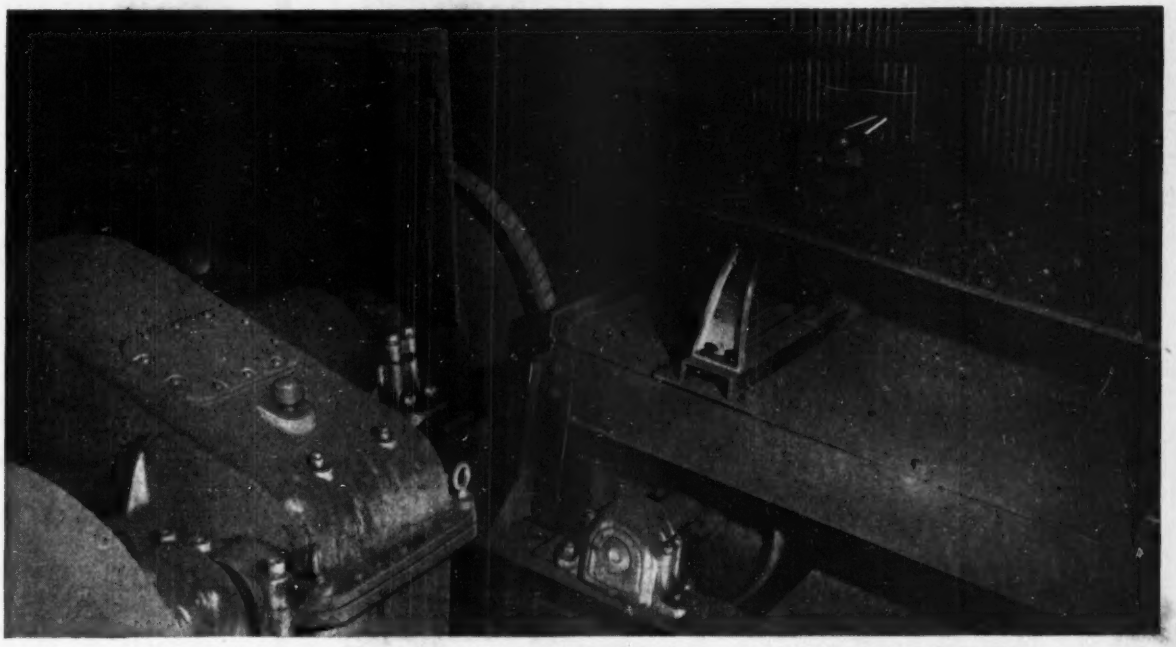
BEAT HIGH TRANSPORTATION COSTS--

carry the load via belt conveyors



Engineered for long-life, this Link-Belt 48-inch wide, inclined belt conveyor employs Series 200 troughing idlers, welded steel pulleys (both plain and rubber lagged), roller bearings and an enclosed gear drive.

LINK-BELT offers you the "total engineering" so necessary for top efficiency

DESIGNED FOR OVERALL EFFICIENCY

Because of its unrivalled experience, Link-Belt can do a better job of gathering and analyzing all data. Proposals reflect this understanding of the most practical way to fit conveyors into your system requirements.

BUILT FOR LONG-LIFE PERFORMANCE

Link-Belt manufactures all components and related feeders and conveyors. You are assured of the right equipment because of this breadth of line. And Link-Belt will supply the highest grade belts engineered to the job.

DELIVERS FULL RATED CAPACITY

Link-Belt follows through on every detail of the job, including electrical controls and even wiring and foundations. What's more, Link-Belt will furnish experienced erection superintendents, staffs and skilled crews.

ASSURES SATISFACTORY PERFORMANCE

When you rely on Link-Belt as a single source for your complete system, Link-Belt accepts responsibility for placing it in full operating readiness. We will also supervise modernization of existing systems.

Next time you're in the market for one belt conveyor or a complete system, call a conveying expert in the Link-Belt office near you. It's his job to help you get the best in belt conveying at the lowest possible overall cost.

LINK-BELT

BELT CONVEYOR EQUIPMENT

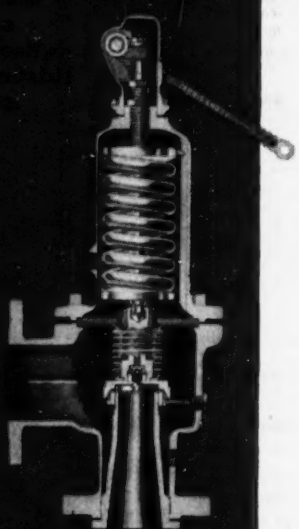
LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World.

19,100-E

Farris

Modern design.... Accepted for dependability... Certified Safe

REALISTICALLY PRICED!



Farris

FULL-NOZZLE

Sizes 1" D 1½", to 8" T 10"

SEMI-NOZZLE

Sizes 1½" F 2", to 6" S 8"

BAR STOCK & HI-PRESSURE

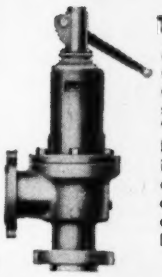
Type 2745—½", ¾", 1"
Type 2740—½" x 1", ¾" x 1", 1" x 1", 1" x 1½"
Type 1430—1¼", 1½", 2"

CORROSION TYPES

Type 1000—½" to 2"
Type 3725—½" to 1"
Type 3775—1½" to 2"

GENERAL SERVICES

Sizes ½" to 6" x 8"

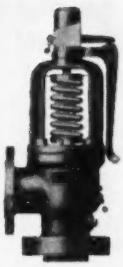


TYPE 2680

Made in Series 30, 60, 90 and 150 inlet flanges, R.F. and R.T.J. Series 15 outlet standard. Available with "FarriSeal" or "BalanSeal" bellows—with or without internal heat exchanger coil; stainless steel, Monel and Hastelloy trim. Plain or packed cap, and open lever types.

TYPE 2610

Made in Series 15 and 30 inlet flanges. Series 15 outlet standard. Parts interchangeable with heavy series valves. Full capacity, economical, for medium pressure range.

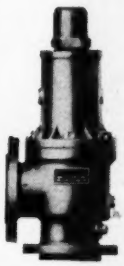


TYPES 2575 to 2578— Series A, B, C

A.S.M.E.—N.B. Steam Generator Safety Valve. Complies with A.S.M.E. Code for fired pressure vessels. The suffix A indicates maximum temperature of 650°. B indicates 750°, using alloy spring; C indicates 900°, using alloy spring and carbon-moly. body. Pressure limits:

2575—300# 2576—450#
2577—600# 2578—900#

These valves are famous for their non-sticking qualities. Available in oversize orifices for greater capacity at slight additional charge.

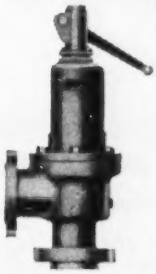


TYPE 2550

Made in Series 250 inlet, 125 outlet. Female outlet size available up to 4". Iron body, bronze or stainless steel trim. (Bronze trim has stainless steel disc as standard.) Stainless steel trimmed valves available with "FarriSeal" or "BalanSeal" bellows, with or without internal heat exchanger coil. Capacity advantages of full nozzle design

TYPE 2250

A.S.M.E.—N.B. Exposed Spring Boiler Safety Valve. 250# inlet, 125# female outlet to 4". Pressure and temperature limits 250# at 450°F. Available in stainless steel or bronze trim. Stainless disc on bronze trim, standard.



TYPES 2570 & 2550 - OL

Made in Series 250 inlet, 125 outlet. Female outlet size available up to 4". Iron body, bronze or stainless steel trim. (Bronze trim has stainless steel disc as standard.) Stainless steel trimmed valves available with "FarriSeal" or "BalanSeal" bellows, with or without internal heat exchanger coil. Capacity advantages of full nozzle design. Type 2550 - OL—Open Lever Construction; Type 2570—Packed Cap and Lever Construction.

TYPE 2745

Sizes ½", ¾" orifice No. 8 (area .019), No. 13 (area .077). 1" orifice No. 12 (area .045), No. 20 (area .250). By far the most outstanding advance in Safety Valve achievement. Nozzle capacity, blow down ring control, self aligning loose disc construction. Made from forged bar stock in four materials: brass, 304 and 316 stainless steel and cold rolled steel. Internal trim, 316 stainless steel. Both pipe connections in body for economical maintenance suitable for pressures to 10,000# on air, gas, oil and water. Type 2747—Packed Cap and Lever Construction.

TYPE 2740

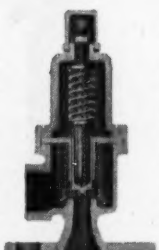
½" x 1", ¾" x 1" with .049 area, 1" x 1" and 1" x 1½" with .18 area. A rugged, simplified design, limited capacity Safety-Relief Valve. Used by refineries particularly where extreme accuracy of blow-down is not essential. Uses: thermal reliefs, pump by-passes, etc.

TYPE 1430

Sizes 1¼", 1½", 2" female inlet and outlet. Heavy duty Safety-Relief Valve, cast steel body, stainless steel trim, with flat seat and disc and blow-down ring for pressures up to 600#. Both pipe connections in body for economical maintenance. For gas or liquid service.

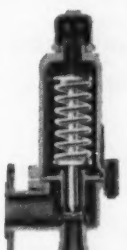
TYPE 1000

Diaphragm Control Relief Valve, sizes ½" to 2" male inlet, female outlet on bronze, 15 series inlet, 15 series outlet on Hastelloy "C" and type 316 stainless steel. Sensitive control with minimum bleed down. For chemical vapor-tight service—liquid or gas. Available with rubber, Neoprene, or molded Kel-F diaphragm and disc.



TYPE 3725

½" and ¾" orifice No. 13 (area .077). 1" orifice No. 20 (area .25). Made in female connections or Series 15, 30 or 60 flanges inlet. With rubber, Neoprene, or stainless steel "FarriSeal" bellows, Hastelloy "C" or 316 stainless steel body and disc. For highly corrosive acid services within the scope of 316 stainless steel and Hastelloy "C".



TYPE 3775

Sizes 1½" to 2", H orifice (area .785). Series 15, 30 or 60 inlet. Series 15 outlet. Rubber, Neoprene or 316 stainless steel "FarriSeal" bellows. Hastelloy "C" or 316 stainless steel body and disc. For highly corrosive acid services within the scope of 316 stainless steel and Hastelloy "C".

TYPE 1808

Sizes ½" to 2½". All Bronze Portable Pop Safety Valve. Male inlet, female outlet. A.S.M.E.—N.B. for steam or air services. Precise operation, economical first cost. Pressure to 250# steam.

TYPE 1400

Sizes ½" to 2½". Low Pressure Liquid Relief Valve, all bronze. Compact, adjustable range. Can be inspected and serviced without breaking pipe connection. Pressures to 250#.

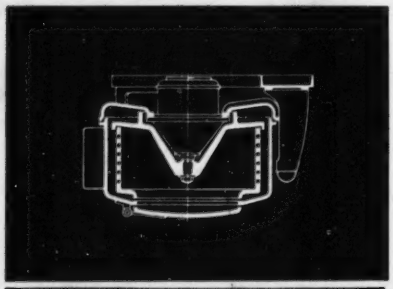
TYPE 2350

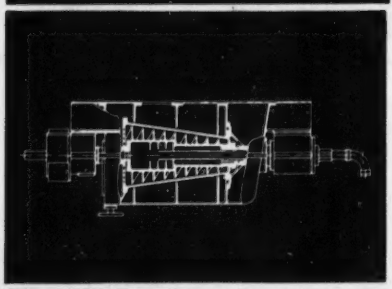
Sizes 1½" x 2" to 6" x 8". Wing guided construction cast iron body, bronze trim. A.S.M.E. — N.B. Boiler Safety Valve, exposed spring, test lever. 250# inlet, 125# or female outlet to 4"

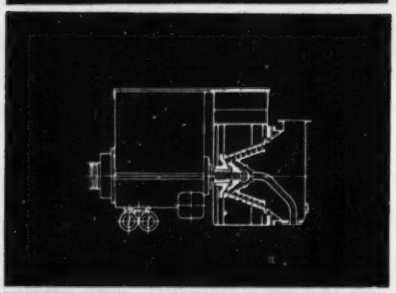
TYPE 2469

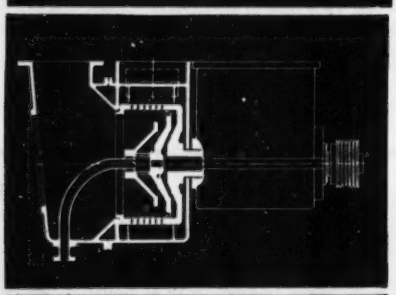
Sizes 1½" x 2" to 6" x 8". Wing guided construction, enclosed spring, test lever. A.S.M.E. — N.B. Cast iron body, bronze trim, 250# inlet, 125# or female outlet to 4".

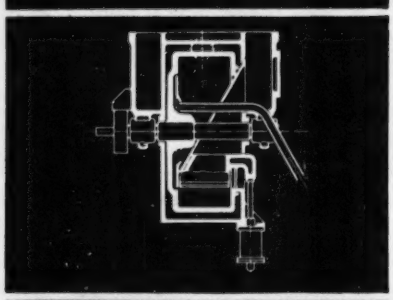
To separate solids from liquids!

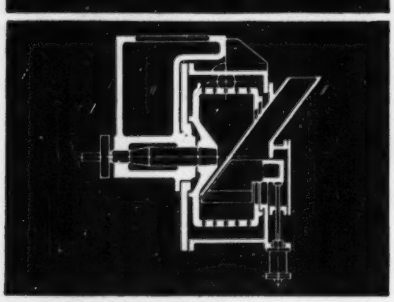












With a view to the large number of materials to be separated this problem can only be solved by applying special centrifuges. A single type can never treat all the materials to ensure most efficient separation.

Krauss-Maffei build the appropriate centrifuges for every application:

automatic screen centrifuges
automatic separators
continuous pusher centrifuges
continuous worm centrifuges with perforated basket
continuous decanting centrifuges
vertical and pendulum centrifuges.

Avail yourself of our experiences to find the right centrifuge for your material.

Ask for our prospectus!

KRAUSS-MAFFEI
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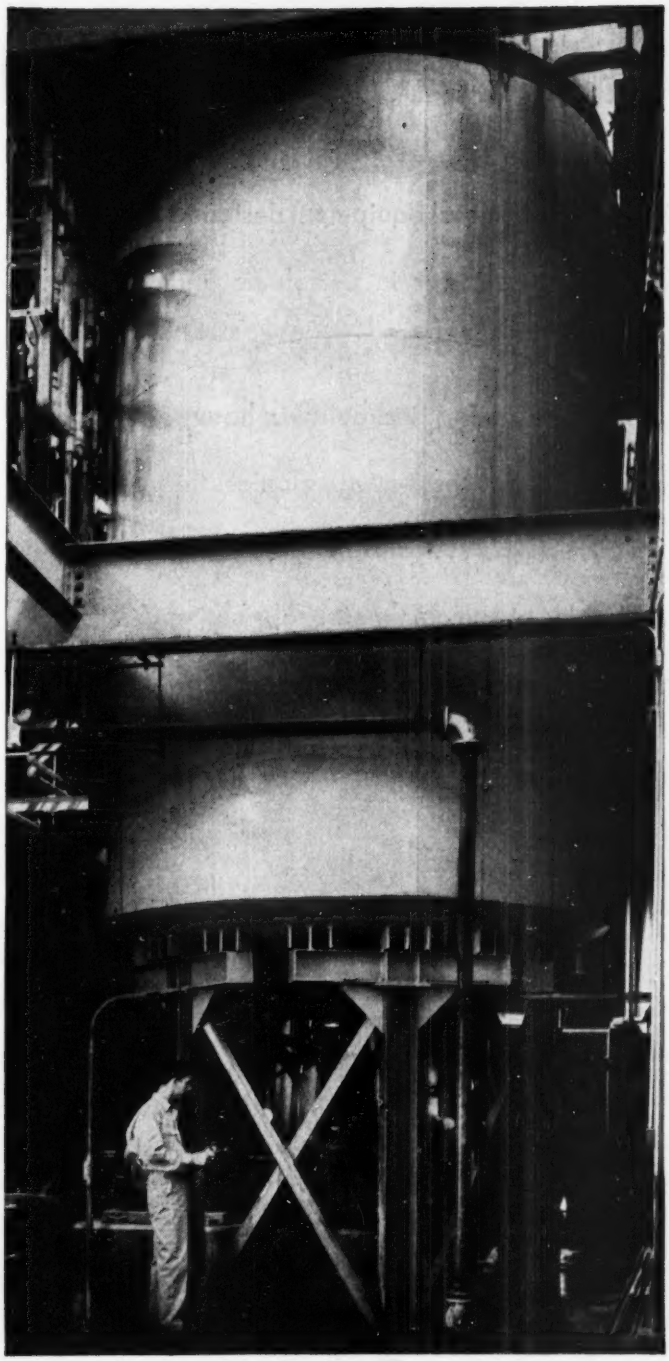
Germany

S-354



Keeping penicillin pure

may hold an idea for you

A pharmaceutical manufacturer formerly made penicillin in steel fermentation tanks. The problem was: how to keep the delicate organisms from being poisoned by the metal?

The answer: the 10,000 gallon tank shown above made of Enduro Stainless Steel. Enduro has no effect on penicillin organisms.

But the manufacturer also found extra advantages in Enduro. Like higher resistance to corrosion. Easy cleanability. Easy sterilization. And low maintenance costs.

No matter which of Enduro's properties you want most, you get the extra ones automatically. For no other commercial metal has the unique combination of physical and chemical properties you find in Enduro Stainless Steel. Republic will be glad to help you use them where they will do the most good. Write to:

REPUBLIC STEEL CORPORATION
Alloy Steel Division · Massillon, Ohio
GENERAL OFFICES • CLEVELAND 1, OHIO
Export Department: Chrysler Building, New York 17, N. Y.

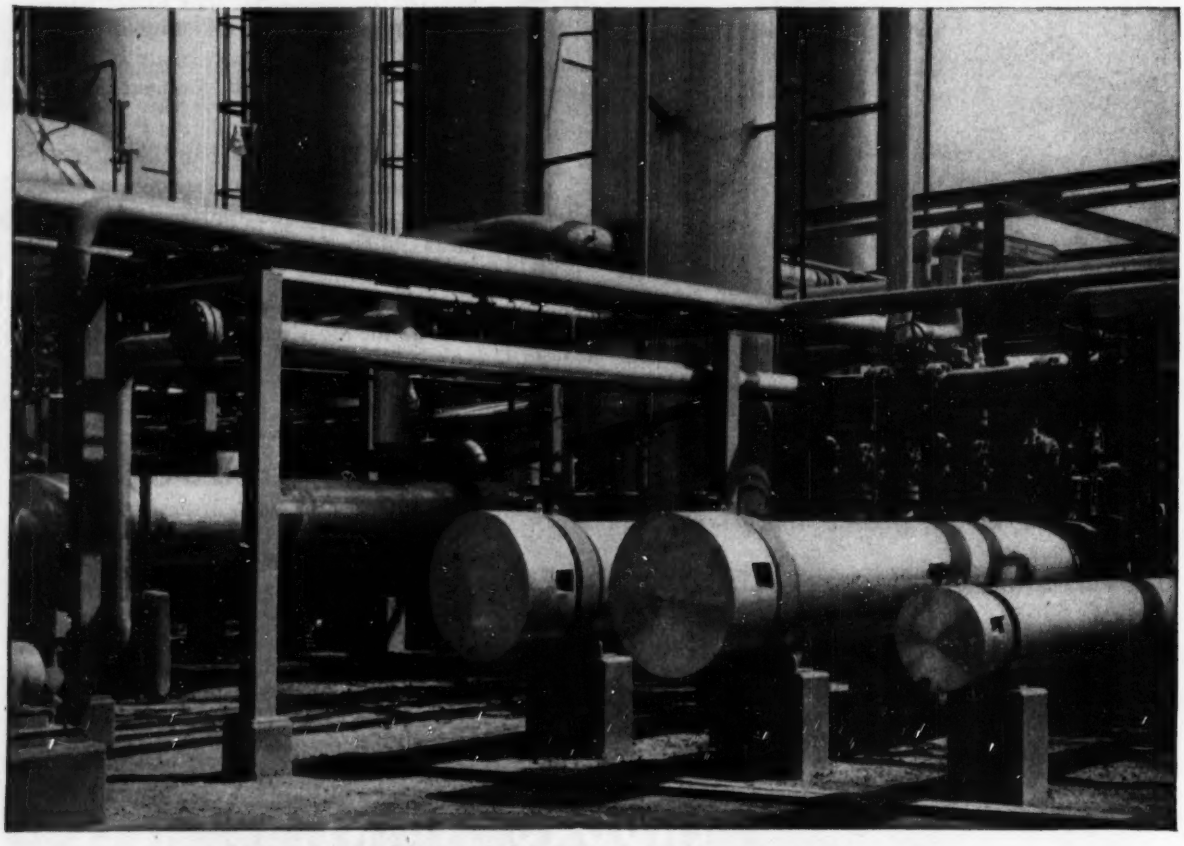
REPUBLIC STEEL

REPUBLIC
ENDURO STAINLESS STEEL

Other Republic Products include Carbon and Alloy Steels — Titanium — Steel and Plastic Pipe, Bolts and Nuts, Tubing, Barrels and Drums

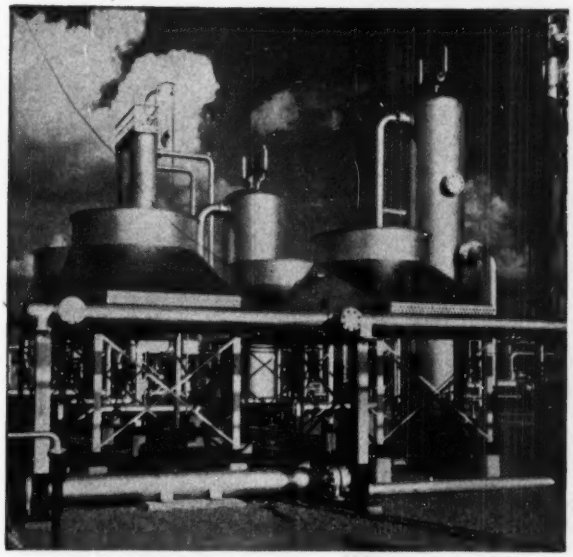
Profit-building answers to Modern

...examples of the wide variety of heavy-metal equipment designed and built by Alco to meet today's demands in petroleum and petrochemical processing . . . results of **Alco Experience** . . . gained through many years of designing and building heavy-metal equipment for refining and processing companies the world over . . . and **Alco Facilities** . . . capable of handling economically an extremely wide range of metal-fabricating operations . . . of meeting strictest customer requirements.

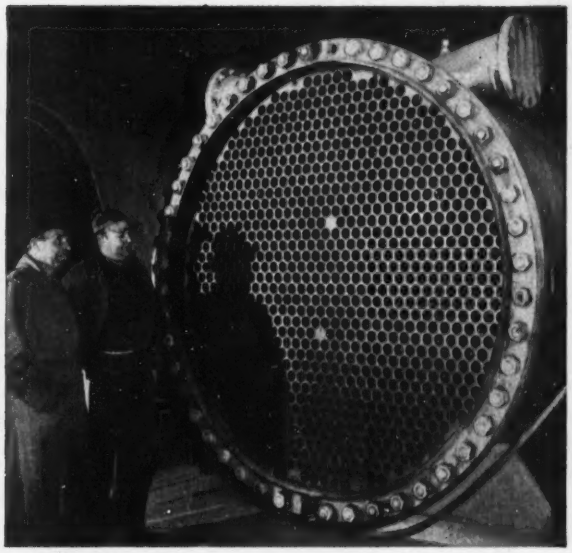


ALCO FEED EXCHANGERS AND REBOILER heat the product stream to the de-ethanizer column at Lion Oil Company's Diamond M-Sharon Ridge gasoline plant in Scurry County, Texas, "The richest county west of Fort Worth." All shell-and-tube heat-transfer equipment at this new, 50,000,000 cu ft-capacity plant is Alco built.

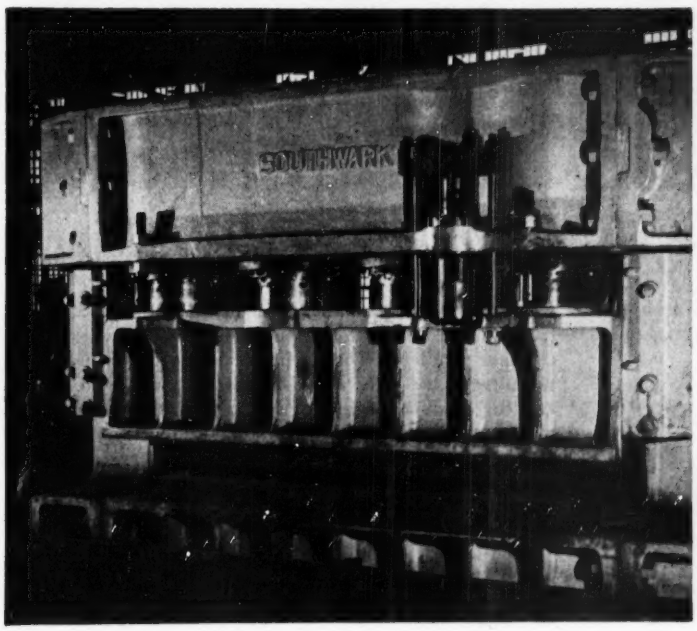
Processing problems



ALCO AIRCOOLERS help cut cooling costs at Sun Oil Company's pressure maintenance station at Allison Ranch, Texas. These modern, high-efficiency units are ideal answers to cooling problems caused by insufficient water supply or high relative humidity affecting evaporative units.



EXHAUST GAS COOLERS custom-engineered by Alco are part of the extensive facilities for testing supersonic aircraft, guided missiles and aircraft engines at the new Arnold Engineering Development Center at Tullahoma, Tenn. Also installed at the Center are 25,000 ft of Alco Steel Pipe.



SCORES OF PROFIT-BUILDING ANSWERS to modern processing problems have taken shape on this large press at Alco's 31-acre Dunkirk plant. This is just one of the many special machines that enable Alco to meet your strictest specifications—quickly and economically.

How about your own processing problems? Is heavy-duty equipment a factor? If so, contact your nearest Alco Products sales representative today—as the first step toward profit-building answers. Offices in Dunkirk, New York, Chicago, Los Angeles, Kansas City, Houston, Tulsa, and Beaumont.

ALCO
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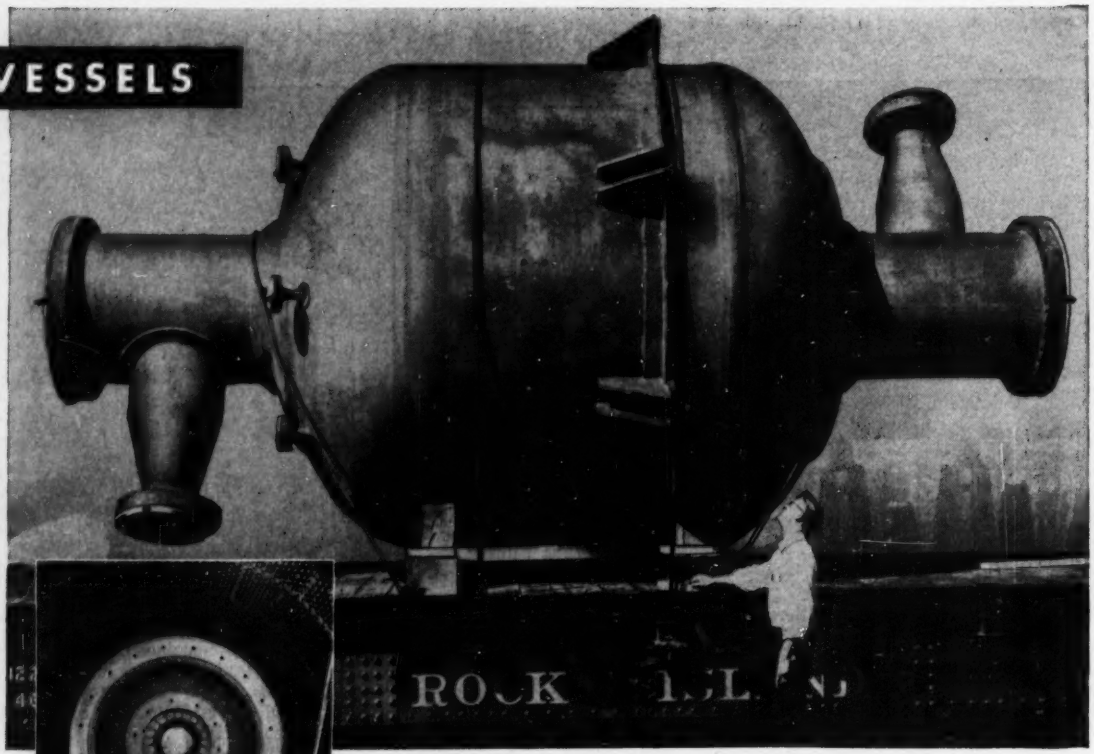
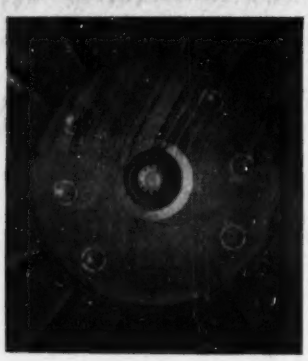
AMERICAN LOCOMOTIVE COMPANY
Sales and Service Offices in Principal Cities

A.O.Smith for

VESSELS



Refractory-lined reactor ready for shipment from the Milwaukee plant. Overall length, flange-face to flange-face: 21 ft. 7 in. Three of these A. O. Smith reactors, when installed, become the heart of a catalytic reforming plant.



These interior views show, *at top:* expanded metal liner support prior to gunniting insulation. Grid platform support rings are visible. *Lower picture* shows shop-installed refractory lining covered by stainless steel lining designed with interlocking expansion joints.

HIGH TEMPERATURE

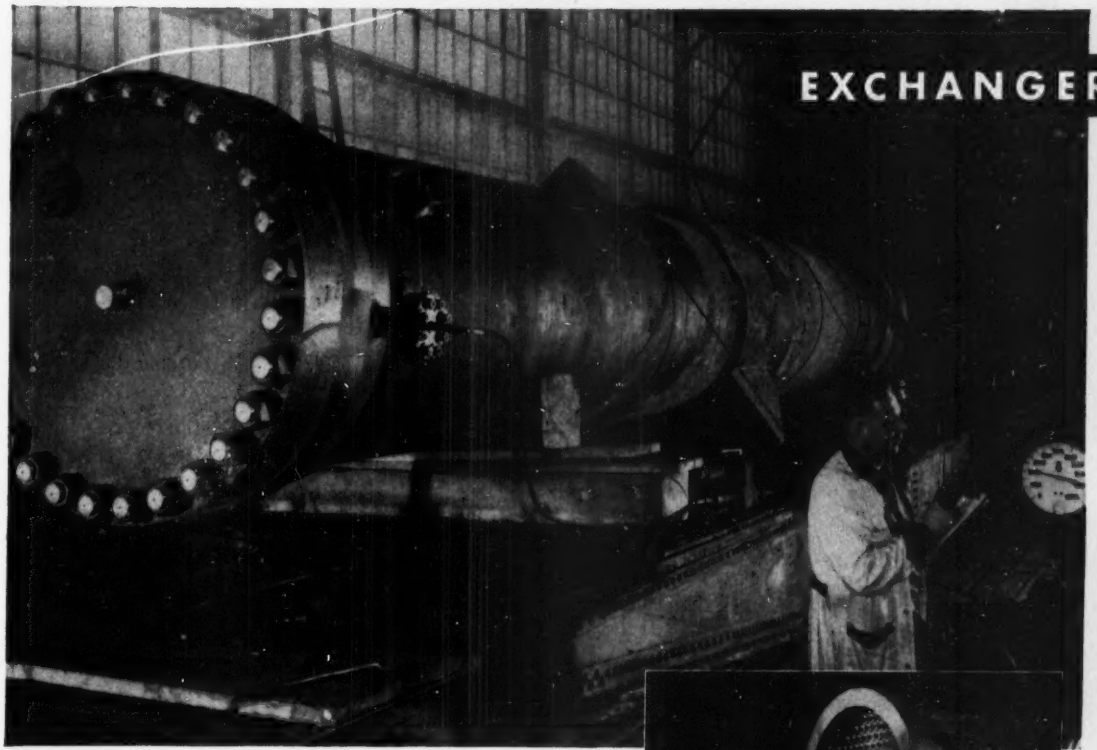
A. O. Smith lined and

For thirty years, petroleum and chemical industries have come to us with pressure vessel and heat exchanger problems. Their reliance on the unmatched advantages we offer in manufacturing know-how and the resourcefulness of our research laboratories and technicians, design engineers and shop men has proved to be well placed. The two reactors shown here are examples of our work.

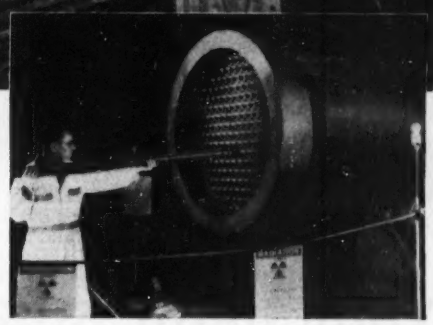
On this page is a special, refractory-lined vessel of A-212 steel, desigued for 650 psi. and temperatures starting at 900° F. The walls are protected by shop-installed refractory lining. Total weight of 50 tons includes 28,000 lb. of lining, its supports

Outstanding Advantages

EXCHANGERS



Shown here is one of twenty poly reactors going through our heat exchanger shop, undergoing tube side pressure test at 2160 psi. One-quarter inch wall tubes are welded to tube sheets and tubes rolled full depth on all poly reactors.



Radioactive cobalt being used for examination of welds during poly reactor construction. This method permits examining welds that are inaccessible to X-ray equipment.

HIGH PRESSURE
tubular reactors

and a catalyst grid platform on pedestal rings.

On this page is shown a poly reactor undergoing shop tests before shipment. Throughout fabrication and long before shop work begins, materials and processes are subjected to exhaustive tests to make sure quality demands are met. Metallurgical, spectrographic and pressure tests during and at completion of construction assure conformity to specifications.

YOU ARE INVITED

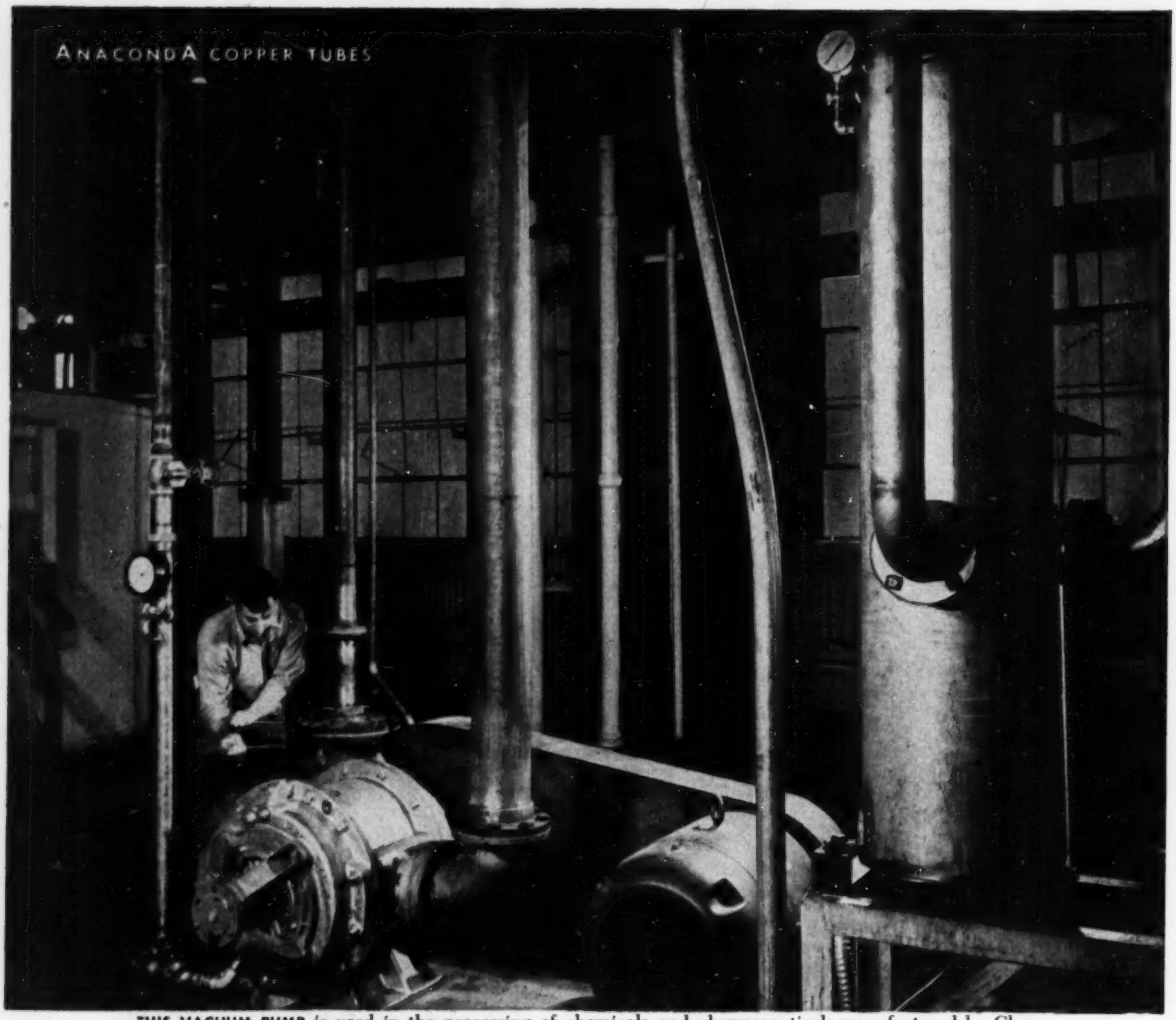
Whenever you have a pressure vessel or exchanger problem, write our Milwaukee office for information about the outstanding advantages which A. O. Smith research, engineering and construction offer.

Through research ... *a better way*

A.O.Smith
CORPORATION

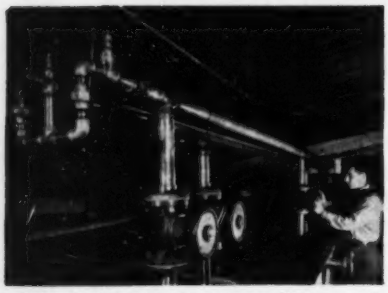
Process Equipment Division
International Division: Milwaukee 1
MILWAUKEE • HOUSTON • LOS ANGELES

For glass-lined process equipment, contact GLASCOTE PRODUCTS, INC., Cleveland 17, Ohio—A new A. O. Smith Subsidiary



THIS VACUUM PUMP is used in the processing of chemicals and pharmaceuticals manufactured by Chas. Pfizer & Co., Inc. 4-in. copper tubes and 6-in. red brass pipe are used for suction and discharge lines.

Your plant piping will last longer —can cost less when it's copper



THESE CHEMICAL PROCESS LINES of 1¼-in. and 2-in. copper tubes in the Chas. Pfizer & Co., Inc. plant use both copper solder-type and S.P.S. bronze fittings joined by silver-alloy brazing.

NOT ONLY the first cost, but how long it will last and how much it costs to install are the measures of true industrial piping costs.

Where corrosion shortens piping life, where rust and scale form to restrict flow and increase pumping costs, there you should consider copper's corrosion resistance and immunity to rust—properties that endow copper piping with its long life.

Lightweight copper tubes are far less costly to erect; when used with solder type fittings, they cost far less to install than heavy, threaded pipe. In fact, it is not unusual for labor savings to bring the installed cost of a copper tube, solder fittings system below that of rustable piping.

For examples of the wide use of copper in industrial piping and for detailed information on ANACONDA Copper Tubes and Solder Type Fittings, let us send you a copy of Publication C-24. Write to *The American Brass Company, Waterbury 20, Connecticut. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.* 5336

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USES FOR PLIOWELD
PROCESSING TANKS—rectangular, cylindrical, all shapes • TANK COVERS—flat, box, arched types • STORAGE TANKS—vertical or horizontal, flat or dished heads • TRUCK TANKS • R. R. TANK CARS • FLANGED PIPE • FLANGED PIPE FITTINGS • FANS—wheels and housings • DUCTWORK • HOODS • SCRUBBERS—air purifiers • AGITATORS • CONTINUOUS VACUUM FILTERS • TROUGHS • CHUTES • PUMPS • FILTER FRAMES • MISCELLANEOUS FABRICATED ITEMS

LATEST move in the transportation of liquid chemicals is the recent launching of the S.S. Marine Dow-Chem. This is the first large-capacity, seagoing chemical tanker to be built in the United States. And the G.T.M.—Goodyear Technical Man—played an important part in its design and construction.

Nestled in the ship's forward hold are six huge, bottle-shaped tanks specifically built for the interchangeable transport of hydrochloric acid and concentrated caustic solution. To handle such corrosive chemicals on an alternating basis, these 40,000-gallon tanks are lined with a custom-made PLIOWELD compound, specified by the G.T.M., but only after six years of laboratory and field tests.

PLIOWELD is a dense, resilient rubber sheet. It can and does resist a wide range of acids, alkalies, salts, alcohols, fumes, gases and water. It also resists abrasion. It always is compounded to withstand the particular corrosives or abrasives to be handled. And it always is permanently bonded to the metal by an exclusive Goodyear process.

If your equipment is threatened by corrosion or abrasion, call on the G.T.M. for protection with PLIOWELD. You can contact him by writing Goodyear, Industrial Products Division, Akron 16, Ohio.

GOODYEAR

THE GREATEST NAME IN RUBBER

We think you'll like THE GOODYEAR TELEVISION PLAYHOUSE—every other Sunday—NBC TV Network

Plioweld—T. M. The Goodyear Tire & Rubber Company, Akron, Ohio

OUF INC.

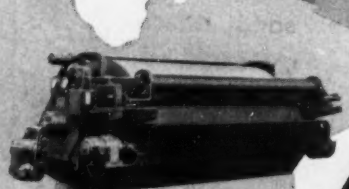
1953

Sweetland Pressure Filter

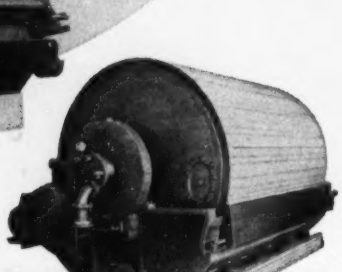
SCORES OF FILTERS

including Oliver Chemical and Metallurgical Filters; Sweetland Pressure Filters, Oliver-Campbell Cane Mud Filters, Oliver Horizontal Filters, Oliver Precoat Filters and American Disc Type Filters. It's interesting to note that in some cases these shipments required several months to reach their destination. One cargo went through five transshipments.

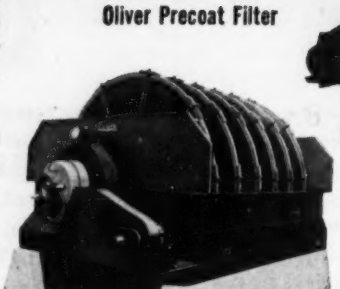
These filters cover only those manufactured in the States at our Hazleton and Oakland factories. Several times this number were manufactured during 1953 in other countries, by our world-wide sales and manufacturing representatives.



Oliver Precoat Filter



Oliver Continuous Vacuum Filter



American Continuous Vacuum Filter

Oliver Horizontal Filter

FOR HANDLING

such products as tin, nickel, aluminum, zinc, uranium and copper concentrates; foundry sand, paper pulp, cane sugar mud, beet sugar carbonates, petroleum products, phosphoric acid, flue dust, pickling liquor, streptomycin, rice bran, volcanic sulphur, titanium solutions.

Oliver-Campbell Cane Mud Filter

IN THE FOLLOWING 20 COUNTRIES:

Argentina	Cuba	Panama
Australia	Germany	Paraguay
Barbados	Hawaii	Peru
Brazil	India	Puerto Rico
Belgium	Jamaica	South Africa
Canada	Japan	Venezuela
Chile	Mexico	

EXPORT SALES

COULD WELL BE YOUR BEST GUIDE IN PLANNING 1954-1955 FILTER PURCHASES

This little 1953 export sales item provides some measure of the high regard in which Oliver United is held throughout the processing world. It's a high regard based on broad knowledge of filtration, wide selectivity of filter types, and world wide service.

Four vitally important requirements entered into all of these purchases. Bearing in mind that the filters were destined for operation thousands of miles from the place of manufacture, you can readily appreciate:

1. **that the filters had to be the right type for the job to be done.**
2. **that they had to assure satisfactory performance.**
3. **that they had to be durable.**
4. **that they had to be backed by competent servicing.**

Can you afford to consider lesser equipment and lesser service when you come to place your 1954-1955 filter order?

When you write or call for further information on Oliver United equipment, we suggest that you outline your filtration, washing or dewatering problem. It will help to expedite matters, if timing is an important factor.

Write or call our main office for bulletins you want.

WHICH OF THESE PUMPS CAN HELP YOU?

We can offer a choice of three distinctly different pumps:

ODS SLURRY-HANDLING
A Diaphragm Pump
(Bulletin 309-R)

OLIVER STAINLESS STEEL
A Centrifugal Pump
(Bulletin 310-T)

OLIVITE ACID-HANDLING
A Centrifugal Pump
(Bulletin 308-R2)

WORLD WIDE SALES, SERVICE AND MANUFACTURING FACILITIES

OLIVER UNITED FILTERS OUF INC.

FACTORIES:
Hazleton, Pa.
Oakland, Calif

NEW YORK 36—33 West 42nd Street • CHICAGO 1—221 North LaSalle Street
OAKLAND 1—2900 Glascock Street • SAN FRANCISCO 11—260 California Street
International Export Sales Office—New York • Cable—OLIUNFILT

KELLEY

Pioneers in HOMOGENEOUS LEAD BONDING

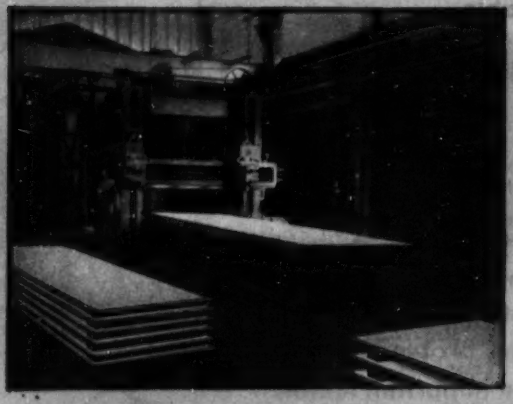
First Again with a "NEW MECHANICAL" Bonding Process

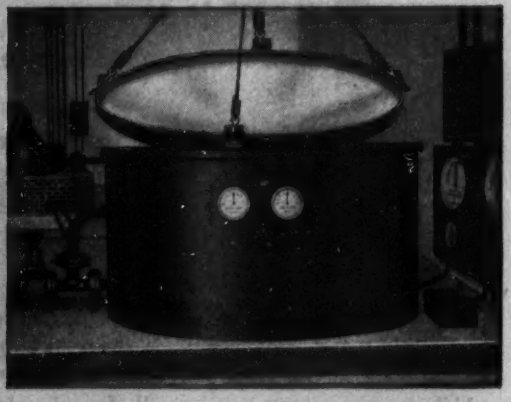
"Our newly developed "mechanical" process for applying Homogeneous Lead Bondings affords you a considerable saving in both delivery time and cost over the slower "hand-burning" method.

We suggest that you pay a visit to our plant and view this newly developed "Mechanical" cost-saving lead bonding process. Our Engineers are available for consultation without obligation. Your inquiries are solicited.

Homogeneous Lead Bondings are applied to any thickness of shell plates in the flat before shaping to your specifications. Plates as large as 10'-0" x 20'-0" are easily handled on our new unit, thus eliminating many unnecessary weld seams. Outlets and connections are Homogeneously Bonded regardless of size.

To insure uniform overall thickness of the Homogeneous Lead Bondings and eliminate the human errors occurring in other methods, lead is applied "oversize" to flat sheet plates and then planed to required thickness. In addition, this operation affords considerable savings in time over the general "Hand Scraping" method.





Dished Heads of all types and various irregular shaped pieces of equipment are Homogeneously Lead Bonded in our Special "MECHANICAL" Unit. Here again, considerable saving in time and cost is effected over the general method.

KELLEY Custom-Built for the Processing Industries

TANKS, LEAD COILS, LEAD & LEAD LINED VALVES
SHEET LEAD LININGS, CASTINGS & FITTINGS

STAINLESS STEEL
LEAD
WOOD
STEEL
Fabrication

O. G. KELLEY & CO.

ENGINEERS DESIGNERS FABRICATORS

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CLEVELAND, OHIO
JOHNSON CITY, TENN.
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HOUSTON, TEXAS
PITTSBURGH, PA.
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For Processes that Demand ACCURATE Adjustable Voltage

POWERSTAT
variable transformers
Hit the Voltage "On the Nose"

If the equipment you are designing calls for *accurate* adjustable voltage, take advantage of the "precision-accuracy" of a POWERSTAT variable transformer. Plus — its excellent regulation . . . high efficiency . . . cool operation . . . and long life.

And the cost? You can buy a POWERSTAT for as little as $8.50!

Dimension-wise and mounting-wise, a POWERSTAT is easiest to install . . . and maintenance is negligible. Write for full details.

Manually-operated and motor-driven POWERSTATS are offered in 120, 240 and 480 volt ratings — from 150VA to 100 KVA.

Be sure to see Superior Electric's Mobile Display when it visits your area.

THE SUPERIOR ELECTRIC COMPANY

1409 CLARKE AVENUE, BRISTOL, CONN.

Manufacturers of: Powerstat Variable Transformers • Stabiline Automatic Voltage Regulators • Voltbox A-C Power Supplies • Powerstat Light Dimming Equipment • Varicell D-C Power Supplies • Superior 5-Way Binding Posts

THE SUPERIOR ELECTRIC CO.
1409 Clarke Ave., Bristol, Conn.

Please send complete literature on Powerstat variable transformers

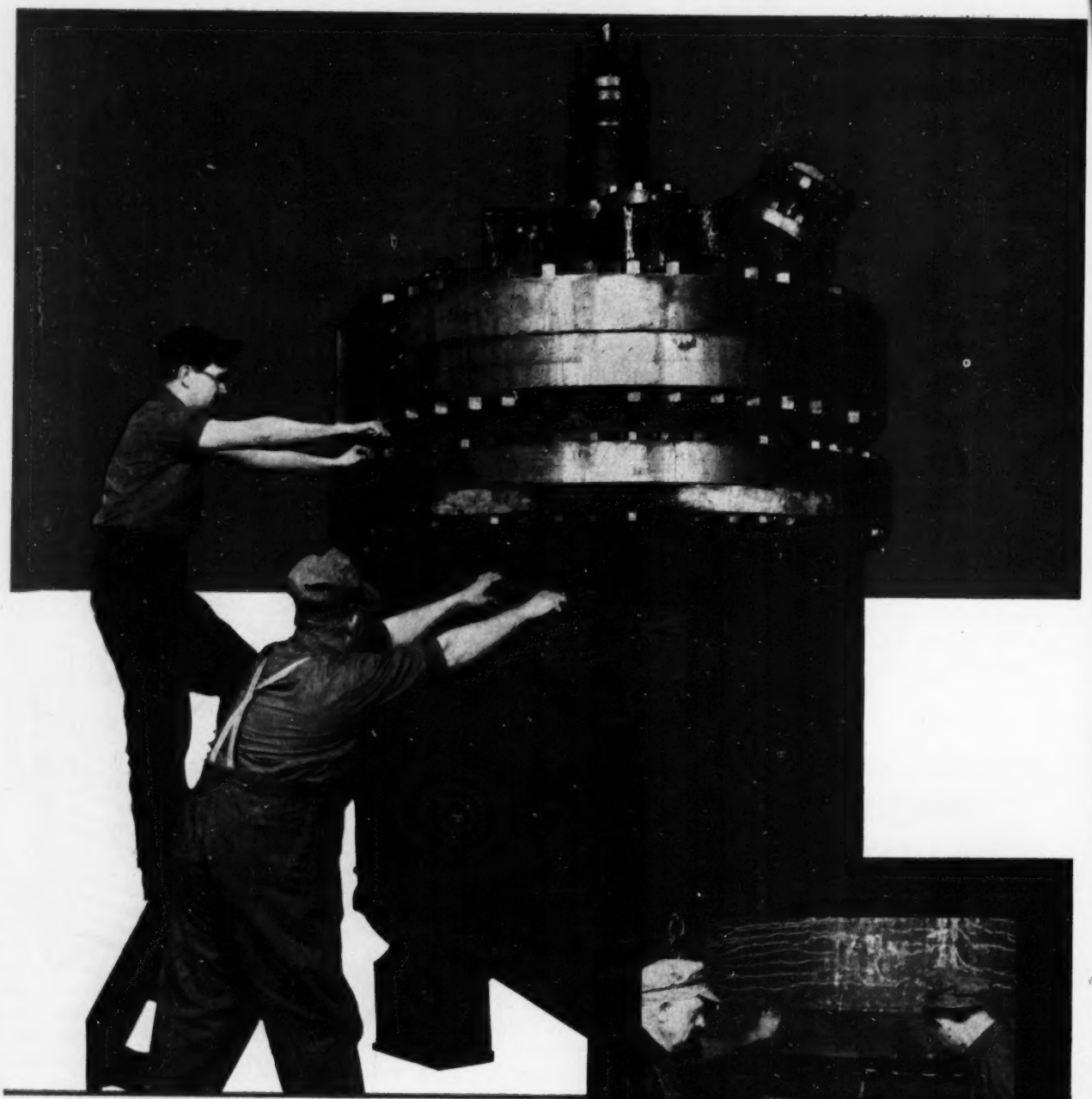
Name .....

Position .....

Company Name .....

Company Address .....

City ..... Zone ..... State .....



(a) 600-gallon Ductile Iron autoclave, weighing 17 tons, made by Cooper-Bessemer for methylation process. Unit was produced to conform with Ohio Special Specification No. 258, revised, of April 30, 1953.

(b) Ductile Iron autoclave body. Note hole where test bar was removed straight through 9" section. Actual bar test showed 61,500 psi tensile; 49,900 psi yield point.

New life for pressure vessels with

HIGH STRENGTH DUCTILE IRON

There is proof today that Ductile Iron offers important new advantages in various temperature-pressure services. A case in point is the 600-gallon autoclave, shown opposite, produced by Cooper-Bessemer for use in a large chemical company's methylation process.

This unit is made of Ductile Iron as a result of extensive testing. Of all materials tested, including various alloy steels, stainless steels and even pure nickel, Ductile Iron showed the greatest resistance to the combination of corrosion and abrasion. And Ductile Iron not only assures this advantage, but provides the necessary strength for high pressure service as well.

Although Ductile Iron, with its unique characteristics, is relatively new, there is nothing new about Cooper-Bessemer's experience in producing pressure castings. We've been at it for *over 100* years. Let's talk about *your* need for autoclaves or other pressure castings.

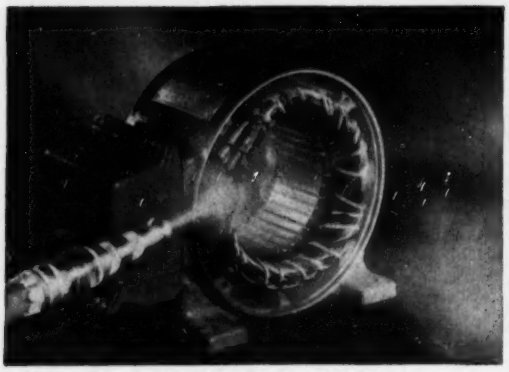
GROVE CITY, PENNA.

COOPER-BESSEMER

MOUNT VERNON, OHIO

Process Industries Division

OVER A CENTURY OF PRESSURE CASTING EXPERIENCE IN SPECIAL IRONS



Here's a Life-Line "A" stator that has been given multiple dips and bakes of Bondite. There is no evidence of vapor penetration after being exposed to the toughest insulation test—a jet of steam.

Try tearing a piece of Life-Line's slot insulation, Mylar*. Mechanical strength is eight times greater than ordinary slot cells. Dielectric strength is ten times greater than standard design requirements.

*Trade Mark for Du Pont polyester film

There's more to motor insulation than its ability to repel water

These demonstrations show how new *Life-Line A* insulating materials provide greater protection for wire, slots and complete stator.

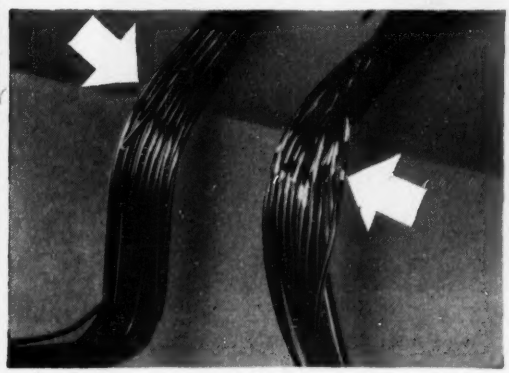
New and improved motor insulations are the word of the day. Actually, there is a considerable range between the run-of-the-mill "improved" insulations and the really outstanding types now available. There is only one way to judge them—by comparison.

For example, many new stator insulations do a more effective job of shedding water. But Life-Line's® new Bondite goes a step further . . . it repels vapors that penetrate ordinary water-shedding insulations.

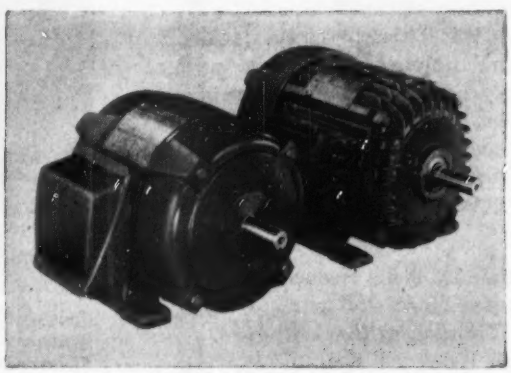
The secret is in the silicone additive that is impregnated throughout Bondite instead of being just applied as a thin outer layer. The complete story of Life-Line's Bondite, Bondar and other new motor improvements is contained in the new Life-Line Booklet B-6154. For your copy, write: Westinghouse Electric Corporation, 3 Gateway Center, P. O. Box 868, Pittsburgh 30, Pa. J-21847-A

YOU CAN BE SURE...IF IT'S Westinghouse

A duck's ability to shed water is only feather deep. A simple wetting agent dissolves the duck's protective coating and he sinks. Many water-shedding motor insulations react much the same; expose them to a simple solvent and they deteriorate.



These two coils have been baked for 50 hours at 400° F. Bent around a finger, the ordinary insulation on the right coil flaked off. Life-Line's Bondar insulation on the left remained intact.



Dependable performance takes balanced design. That's why *every* component in the new Life-Line "A" has been redesigned and integrated with the whole. The result is a motor with superior performance.

There's more to instrumentation than instruments

Instruments can do wonders, if they're given the chance. But some one has to put them to work in the most effective way. And that's where Honeywell Application Engineering steps in.

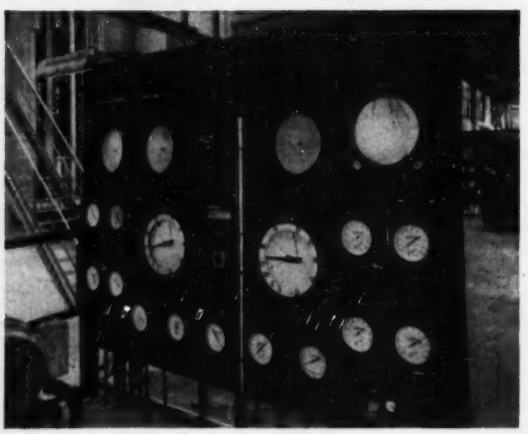
This service is one of the most important plus values you get in Honeywell instrumentation. It's a teamwork job. And every member of the team is an expert in his own field. Engineering begins right in your own plant, where a Honeywell field man digs out the vital facts about your process. He sits down with your engineers, production men and instrument technicians . . . and finds out everything he needs to know about what needs to be measured or controlled, to what accuracy, and under what conditions.

Then the problem goes to Honeywell's Application Engineering staff. Here's where you'll find groups of instrumentation specialists for every major industry. One group, for example, is devoted to the control problems of the metalworking industry. Another handles ceramic applications . . . another chemical . . . until together they cover the whole gamut of modern processes. These men know their specific field from years of first-hand experience. They're thoroughly familiar with the techniques of processing and the ways that instrumentation should be applied.

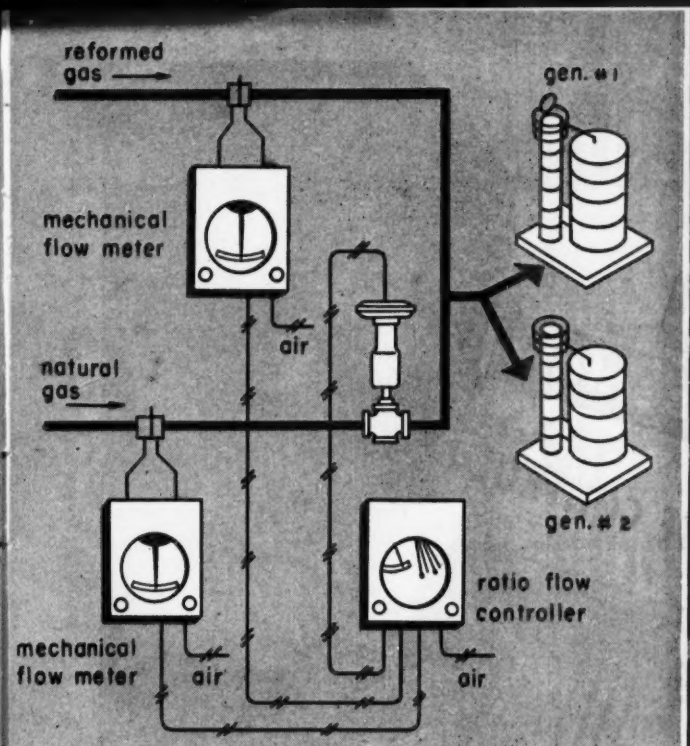
Honeywell Application Engineers develop detailed recommendations for the complete installation. They determine the most effective instruments, primary elements, types of control and valves for every phase of measurement and control. They add switches, signals, interlocks and other accessories which their experience indicates are needed in the interest of safety and convenience. Then they combine all components into a complete system—whether it involves a single instrument or a whole panel—that is designed for peak production efficiency, simple maintenance, and greatest convenience to operators.

This service saves time by doing engineering work that would tie up your own staff for many hours. And it pays off in assuring the excellent performance of which Honeywell instruments are capable.

Ratio controller regulates critical gas mixtures in



Control panel for carbon black generators includes (in upper right corner) Brown ratio flow controller . . . along with ***ElectroniK*** *instruments for checking temperatures inside the generators.*



Brown flow transmitters are mounted outdoors, next to natural gas and reformed gas lines. Diagram shows the complete ratio control system supplying a pair of carbon black generators.

carbon black production

Got a process in which two different gases must be supplied in exact proportion? Godfrey L. Cabot, Inc., were faced with a problem like this in their thermal carbon black plant near Franklin, Louisiana. And the Brown flow control system that was developed for this job in cooperation with The Gas Machinery Company may give you some ideas for your own applications.

The Cabot process cracks carbon out of natural gas, in cyclic reactors or generators designed and built by The Gas Machinery Co. To produce various grades of black, the natural gas fed to the generators must be diluted with reformed gas. A Brown two-pen ratio flow controller, working with two Brown mechanical flow meters, does the trick. The flow meters measure the flow in both the natural and reformed gas lines, and each transmits air pressure signals to actuate one of the ratio controller's pens. On the basis of these signals, the controller regulates a Honeywell diaphragm valve in the natural gas line, to maintain the required ratio of flows of natural gas and diluent.

This simple, rugged system provides excellent accuracy, to keep flow ratios at optimum values. It's versatile, too . . . can be readily set to allow feed of straight natural gas when coarse grades of carbon are required.

Many other types of flow instrumentation are available from Honeywell for the varied requirements of chemical processes. Your nearby Honeywell field engineer will be glad to discuss your specific applications . . . and he's as near as your phone.

Minneapolis-Honeywell Regulator Co., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.

● **REFERENCE DATA: Write for new Catalog 2320, "Flow Meters, Indicating, Recording, Integrating and Controlling."**

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS
First in Controls

NOW

you can operate small valves economically & safely

with Limitorque® REMOTE CONTROL

The new SMA-00 and SMA-000 LimiTorque Valve Control is the latest and most advanced method of operating small valves, ranging from 1½" up to 8" in diameter. These units provide complete safety to workmen, by eliminating the need of climbing to high or hazardous locations for manual valve operation. The valve operating parts are protected by two limit switches ...One provides uniform valve seating thrust, giving positive protection to the parts from overload. The second switch is the geared limit, which controls the stem travel for both directions.

SMA-00 and SMA-000 LimiTorque Valve Controls offer an extremely economical, and simple method of motorizing smaller valves. These Operators can be readily applied to all types of Valves: Gate, Globe, Plug and Butterfly . . . and may be had to actuate by a wide range of power sources including Electricity, Hydraulic Pressure, Natural Gas or Air.

For full details and information regarding these new LimiTorque Valve Controls, write for latest Bulletin.

PHILADELPHIA GEAR WORKS, INC.

ERIE AVE. AND G ST., PHILADELPHIA 34, PA.
NEW YORK • PITTSBURGH • CHICAGO • HOUSTON • LYNCHBURG, VA.

Industrial Gears & Speed Reducers

LimiTorque Valve Controls

DESIGN and PRODUCTION NEWS

FOR PLASTICS AND MATERIALS ENGINEERS

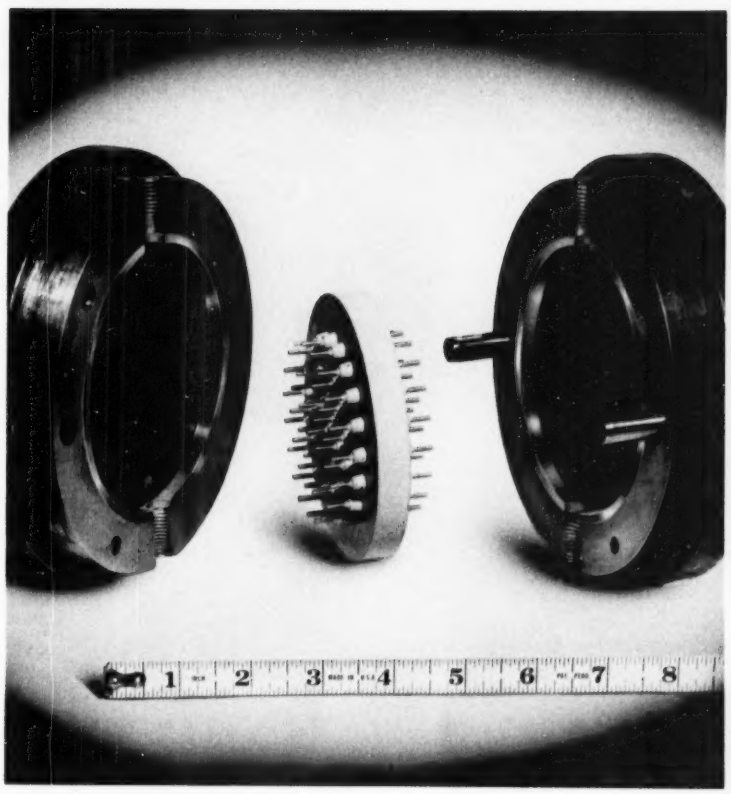
Published by TECHNICAL SERVICE, Chemical Manufacturing Division, The M. W. KELLOGG Company AUG.-SEPT. 1954

Casting Molds of KEL-F® Polymer Replace Plated Metal Molds... Cut Costs, Finishing and Rejects!

Complex electrical terminal boards, made of an especially abrasive epoxy compound, are now cast in molds of KEL-F polymer, replacing former metal molds. Advantages include lower original mold costs, lower maintenance costs, fewer rejects and higher product precision without extensive machining.

Excellent wear characteristics of the new molds result in longer mold life despite high silica content of the casting resin. The non-hesive properties of KEL-F polymer prevent pitting by the resin, result in damage-free release of the product without special coatings. Penn-Plastics Manufacturing Company, Glenside, Pa., produce these intricate new molds by transfer methods. Molded of KEL-F polymer Grade 300, they are designed to hold 40 terminal pins and to impress forty 1/16" numerals in both faces of the finished part. Terminal boards are manufactured by Penn-Plastics in conjunction with Woodmont Products, Inc., electronic parts manufacturers of Huntingdon Valley, Pa.

For further information ask for Application Report P-101



New Bearings of KEL-F® Polymer Eliminate Shaft Seizing... Need No Lubrication!

Shaft seizing is stopped and lubrication is eliminated when rotating metal plating racks are equipped with end bearings of KEL-F polymer. Chemically inert, the tough plastic bearings are unaffected by the most corrosive cleaning and plating solutions...allow smooth rotation. Bearing "drag" is low because the fluorocarbon is dimensionally stable. It will not swell or shrink in contact with water, steam or chemical vapors.

Kurz-Kasch, Inc., plastic molders of Dayton, Ohio, compression-mold the two-piece bearings from KEL-F polymer Grade 300 for use in plating equipment manufactured by The Stolle Corporation, Cincinnati, Ohio.

For further information ask for Application Report C-117

(SEE REVERSE SIDE)

DESIGN and PRODUCTION NEWS

CONTINUED FROM PRECEDING PAGE

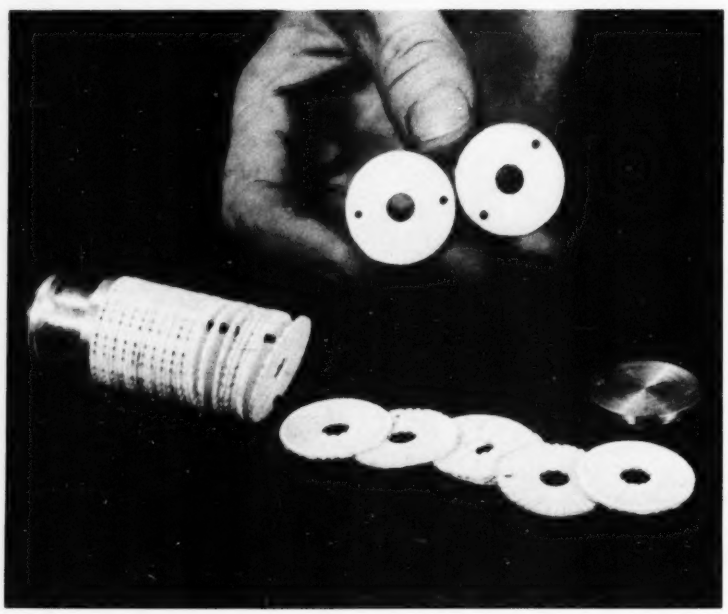
New Aircraft Fuel and Oil Filter Uses Porous KEL-F® Plastic . . . Gains Increased Efficiency, Longer Service Life

High strength in contact with corrosive aircraft oils and fuels at elevated temperatures, high filtering efficiency and simple field maintenance make this a superior filter.

Consisting of a "stack" of discs molded of KEL-F polymer, the porous plastic withstands pressure surges and thermal cycling without rupturing. Corrosives such as fuming nitric acid, hydrogen peroxide and hydraulic and lubricating oils are handled by the chemically-inert porous plastic. Throughput is increased simply by adding on more disc combinations.

The unique filters are manufactured by Aircraft Porous Media, Inc., Glen Cove, N. Y., and employ discs molded of KEL-F polymer Grade 300 by the Porous Plastic Filter Company, also of Glen Cove, N. Y.

For further information ask for Application Report C-11B



Molders & Fabricators of the Month

Leading molders, extruders and fabricators specialize in the production of materials and parts made of "Kel-F" . . . each month this column will spotlight several of these companies with their principal services and products.

Consolidated Molded Products Corp.
Scranton, Pa.
Compression & transfer molding
Injection molding

Cortland Industries, Inc.
Chicago, Ill.
Sealing of film
Production machining

General Plastics Corporation
Paterson, N. J.
Dispersion Coating

United States Gasket Company
Camden, N. J.
Extrusion
Forming & machining
Injection, compression & transfer molding
Rod, tube and sheet; tube sockets
Gaskets, gauge glasses & tower packing

The William Brand and Company, Inc.
Willimantic, Conn.
Insulated wire

Recent Significant KEL-F Polymer Developments . . .

Pyrex-to-steel seal is effected in a new centrifugal pump with a resilient O ring of KEL-F plastic. Damage to the glass observation plate, leaks at high pressures have been eliminated.

Electronic tubes used at high altitudes are now hermetically sealed in new sockets made of fluorocarbon plastic. Consistent hermetic seal over a wide temperature range, low "arc-over" and shock damage are major features.

Conductivity cell-valve units for testing potable water use KEL-F polymer as a structural and electrical insulating member. Immersed continuously in water at temperatures up to 250°F, machined insulator maintains critical electrode gap.

Pump vanes of molded glass-filled polymer have been found to have the necessary strength as well as complete chemical inertness to stand up under hot, extremely corrosive chemicals in a new transfer pump.

OFF THE PRESS . . .
Revised "BUYERS GUIDE" listing KEL-F polymer products, molders and fabricators.

For complete information regarding any item mentioned in DESIGN AND PRODUCTION NEWS, ask for detailed APPLICATION REPORTS, write

Technical Service
CHEMICAL MANUFACTURING DIVISION
THE M. W. KELLOGG COMPANY
P. O. Box 469, Jersey City 3, N. J.
or offices in Boston, Chicago, Dayton, Los Angeles and New York

M W KELLOGG PULLMAN

FINANCIAL AID TO HIGHER EDUCATION

What Business Can Do to Help Our Colleges and Universities

Is the financial squeeze now gripping our colleges and universities grave enough to warrant direct action by the business community? If so, what can business do about it? This editorial is addressed to these two questions.

In the previous editorial in this series of two, it was demonstrated that **our colleges and universities, and particularly the independent institutions, face financial difficulties, which, unless relieved, promise to get progressively worse and might ultimately result in a national disaster.** This state of affairs obviously gives the business community a crucial stake in helping to relieve the plight of these institutions. For our business organizations can be no stronger than the total community of which they are a part.

It does not follow automatically, however, that every business firm should give direct financial aid to education. Already the business structure is heavily burdened with activities unrelated to its main purpose. These include acting as tax collector for more than $65 billion of federal, state and local taxes in the year 1953. There is a limit to the amount of such public enterprise that can be loaded on the business system.

Business Holds Key to Answer

If, however, the survival of a key part of our educational system depends on its having financial help from the business community, that help should be provided. And this is the situation of our independent privately endowed colleges and universities.

Of course, our tax-supported institutions of higher learning must also be kept strong, financially and otherwise. But they have recourse to public support not available to the independent institutions. Largely on this account, their present financial difficulties are much less acute than those of the independent colleges and universities.

These independent institutions have seen price inflation eat away much of the value of their endowments. Moreover, there is no prospect that these endowments can be sufficiently replenished by gifts from the wealthy people who provided them in earlier years. Progressive income and estate taxes have seen to that. Thus, they are faced not only with a peculiarly acute financial problem, but also one which cannot be solved except by tapping other sources of aid.

Tax Support No Solution

It is conceivable that the independent colleges and universities might solve their financial problem by seeking support from tax revenues. If they did this, however, they would lose their distinctive character as independent institutions, and our system of higher education would lose one of its major elements of strength. That is the existence in our educational system of both independently financed and tax-supported colleges and universities. Each has its special contribution to make to a well-balanced system of higher education.

Business is directly dependent upon higher education to staff its increasingly complex and exacting operations. A key part in this process is played by the small, independent liberal arts colleges which are the hardest hit financially of all our institutions of higher learning. "These," states the Council for Financial Aid to Education, recently formed by a group of business leaders, "have contributed a high proportion of the intellectual, scientific and religious, as well as business leadership of the nation. Their programs are devoted to the teaching of values, particularly the values of freedom. They are a vital bulwark to our system of free enterprise."

Means of Providing Help

There are many means by which business firms can extend help to our colleges and universities. The most obvious, of course, is to make outright grants of money either to individual institutions or to groups of institutions for such uses as the institutions think best. Another means of help, increasingly employed by business firms, is to establish scholarships to pay the full cost of college or university courses of study. Sometimes the scholarships are open for general competition, sometimes they are limited to employees and children of employees of the firm granting them. Not infrequently those winning the scholarships spend some part of their school vacations working in the companies granting the scholarships.

A number of companies have recently provided for what have come to be called "scholarships in reverse." These companies pay a flat sum to a college or university for every one of its graduates they employ. Financing of university research programs also offers a broad avenue for financial aid to our universities by business.

Need Two-Way Communication

Some business firms have well-developed programs for financial aid to education. But they are exceptional. For most companies the problems involved are new and strange. These companies were created with the basic purpose to make money, not to give it away. Successful philanthopic operations involve a whole set of problems with which they have very little experience. Not the least of these is how to make business a dependable source of financial aid to education, since business has no assurance that the profits of one year will not be losses the next.

Considerations such as these emphasize the wisdom of a recent Industry-College Conference on aid to higher education by business, in making the first of its ten conclusions that "better communication, by direct contact, is needed for each [industry and the colleges] to understand the problems of the other." At this juncture the creation of mutual understanding is much more important than the raising of some money and letting it go at that. The problem of aid to education by business has its immediate urgency, but there is also a long-range program to be developed on which business and the colleges and universities must pull together in the years ahead to find a satisfactory solution.

As stated at the outset, failure to find a satisfactory solution could result in a national disaster. This means that, **to give proper heed to their own future prosperity and the future welfare of the nation, business firms generally must go to work on the problem of financial aid to higher education. They must go to work first, to understand the problem; second, to establish two-way communication with our colleges and universities about it; and third, to develop a program which pays proper heed to the needs and capabilities of both business and higher education.**

This message is one of a series prepared by the McGraw-Hill Department of Economics to help increase public knowledge and understanding of important nationwide developments that are of particular concern to the business and professional community served by our industrial and technical publications.

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Donald C. McGraw

PRESIDENT

McGRAW-HILL PUBLISHING COMPANY, INC.

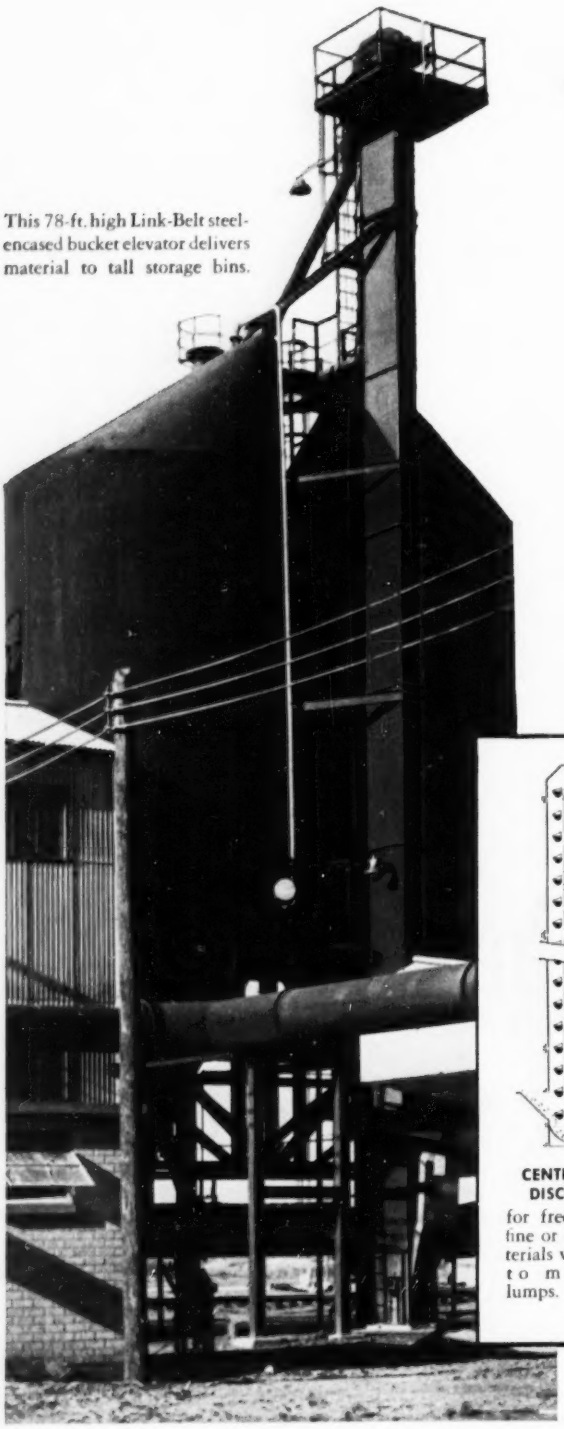
Sulfuric acid goes hungry here

Takes a pretty tough alloy to keep sulfuric acid on a starvation diet.

Yet these 8" gate valves of corrosion-resistant *Aloyco 20* do just that. They control the acid flow to four large absorbing towers in U.S. Industrial Chemicals' new 300-ton acid plant. Built by Leonard Construction Company at Tuscola, Illinois, it supplies acid for National Petro-Chemicals Corporation and the general market. *Aloyco 20* valves are standard throughout the plant for handling sulfuric acid.

Here, as in scores of industrial processing plants, Aloyco Valves speed the flow of chemical progress. **Alloy Steel Products Co., Inc., 1301 West Elizabeth Avenue, Linden, New Jersey.** 4.4

Keep your cost of lifting down



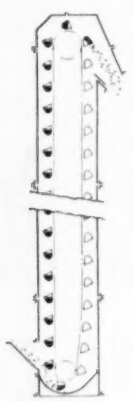
This 78-ft. high Link-Belt steel-encased bucket elevator delivers material to tall storage bins.

Let LINK-BELT recommend the bucket elevator that best meets your requirements from 13 types in 4 basic designs

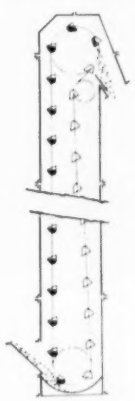
WHEN a materials handling problem occurs concerning the elevation of loose materials, the first solution is usually a bucket elevator. And, because Link-Belt builds a type and size for a complete range of materials and capacities—you're sure to get the one that's right for your job.

Equally important, when you choose a Link-Belt bucket elevator, you get the lowest possible installation, operating and maintenance costs. Rigid jig-built casings are self-supporting, require only occasional lateral tie-ins depending on height. Periodic inspection is speeded with easy access to both head and boot. Chain or belt tension is maintained at all times with screw or gravity take-ups.

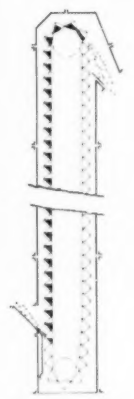
For expert engineering cooperation, call your nearby Link-Belt office. You'll get an unbiased recommendation . . . with no obligation, of course.



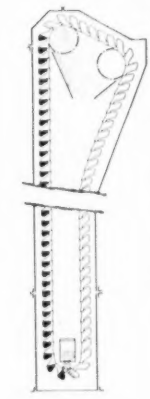
CENTRIFUGAL DISCHARGE
for free-flowing, fine or loose materials with small to medium lumps.



POSITIVE DISCHARGE
for light, fluffy, fragile or materials that tend to stick to the buckets.



CONTINUOUS DISCHARGE
for range of materials—light to heavy, small to large, abrasive lumps.



INTERNAL DISCHARGE
for gentle handling of pellets, washers, bolts, stampings, cartridge casings, seeds, etc.

LINK-BELT

BUCKET ELEVATORS

13,543

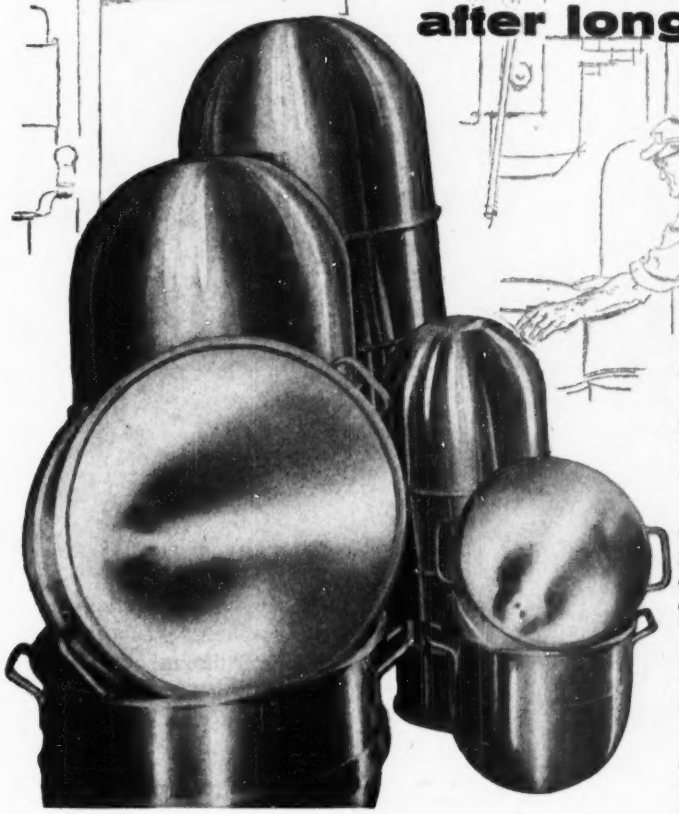
LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Sydney; South Africa, Springs. Representatives Throughout the World.

Mixing bowls made of Crucible stainless steel by American Car and Foundry Company, at its Milton, Pennsylvania plant.

CRUCIBLE STAINLESS STEEL

keeps its shine

after long, hard wear...



The fact is stainless steel improves with wear, for the more it is used the harder and smoother the surface becomes. And there is never any surface plating to wear on a stainless product, for stainless steel is *stainless* all the way through.

Yes, Rezistal® stainless is a *natural* for products that must take long hard service, or that must resist corrosion or wear, or stand up under daily cleaning with strong detergents. Take, for example, the stainless mixing bowls shown. They'll give many years of trouble-free service. And their smooth, sanitary surface makes them especially suited to the processing of baked goods, candy, cosmetics or chemicals.

Be sure you take advantage of all the money- and time-saving qualities of stainless steel. And be sure you specify Crucible stainless . . . made by the country's leading producer of special purpose steels. You'll get fast delivery of the grade and size you need when you call Crucible.

CRUCIBLE first name in special purpose steels

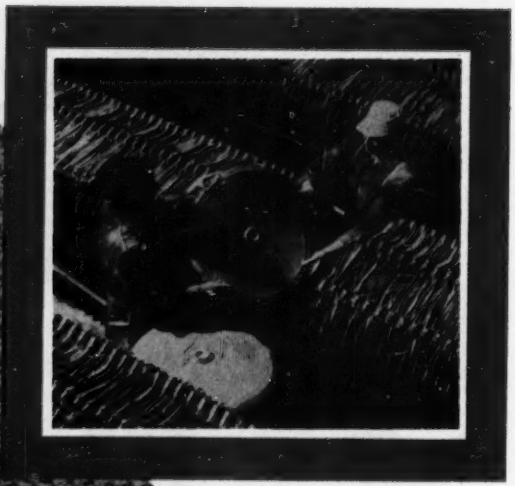
54 years of Fine steelmaking **STAINLESS STEELS**

CRUCIBLE STEEL COMPANY OF AMERICA, GENERAL SALES OFFICES, OLIVER BUILDING, PITTSBURGH, PA.

REX HIGH SPEED • TOOL • REZISTAL STAINLESS • MAX-EL • ALLOY • SPECIAL PURPOSE STEELS

UNIFORMITY

Makes The Big Difference In FILTER FABRICS



MT. VERNON EXTRA

Gives You Greater Fabric Uniformity

Checking evenness of roving with Belger Tester. One of a series of comprehensive laboratory controls throughout production to assure uniformity in all Mt. Vernon-Woodberry products.

FABRICS ENGINEERED TO FIT YOUR NEEDS

Need adaptation of an existing fabric to your special purposes? Or creation of an entirely NEW fabric – cotton, synthetic or blend – to meet your specifications? Mt. Vernon-Woodberry's staff of textile engineers is available on request to help you with your problems in development or application of industrial fabrics.

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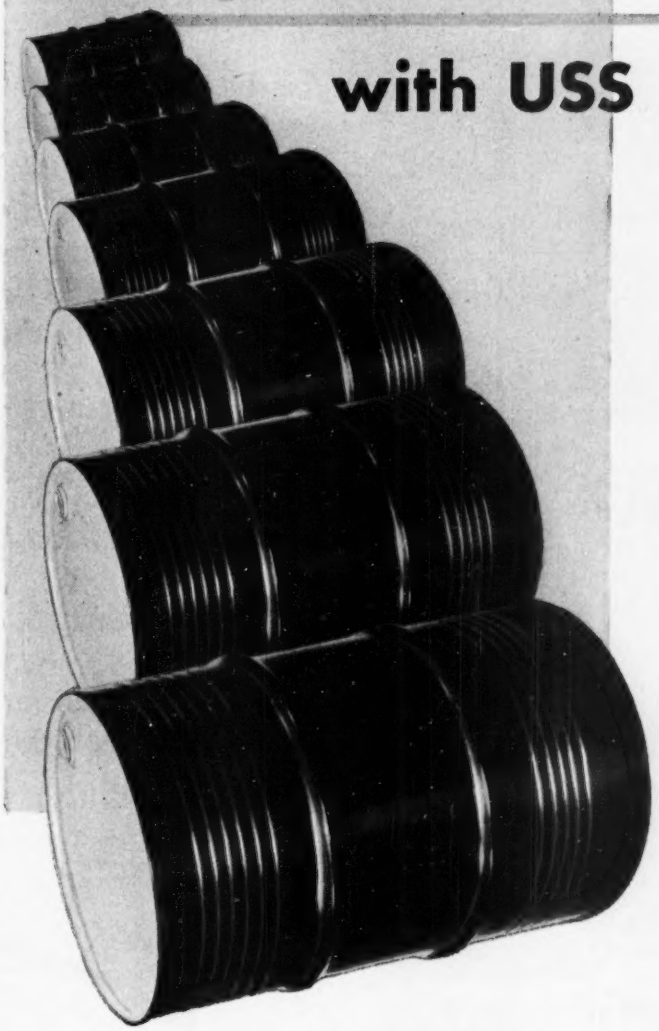
TURNER HALSEY COMPANY
Selling Agents

You get "built-in" quality control with USS Steel Drums



EFFECTIVE quality control *can* be extended beyond your own manufacturing operations. It can go right along with your product after it leaves your plant . . . when you use USS Steel Drums. This means the end of costly customer claims that result from scale, dirt, grease and rust contamination. For now, with scale-free, rust-inhibited USS Steel Drums, you can guard the quality of your product between the time you ship it and the time the customer actually uses it.

These sturdy steel containers are made of high grade USS Steel. A truly effective rust-inhibiting coating has been applied to a surface that has been cleaned — physically and chemically — so completely that the protective coating will not flake off or be undermined by rust and corrosion. USS Steel Drums are better for you . . . better for your customers.

• • •

United States Steel Products fabricates stainless, galvanized, tinned, painted and decorated drums and pails. Furnished in a wide range of capacities with a variety of fittings and openings to meet your particular requirements.

WRITE FOR FREE BROCHURE

If you want further information on this quality steel drum, write to us at New York for this full-color brochure, "USS Drums — 100% Scale-free and Rust-inhibited."

"It's Better to Ship in Steel"

UNITED STATES STEEL PRODUCTS
DIVISION

UNITED STATES STEEL CORPORATION, DEPT. 294, 30 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.

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USS STEEL DRUMS

USS

UNITED STATES STEEL

IT'S THE COMBINATION THAT HELPS YOU *Relax!*

COOPER ALLOY

THE COOPER ALLOY FOUNDRY CO. • HILLSIDE, N. J.

Los Angeles, San Francisco, Oakland, Houston, Chicago, Detroit, Philadelphia, Hartford

Leading producers of STAINLESS STEEL valves, fittings and castings

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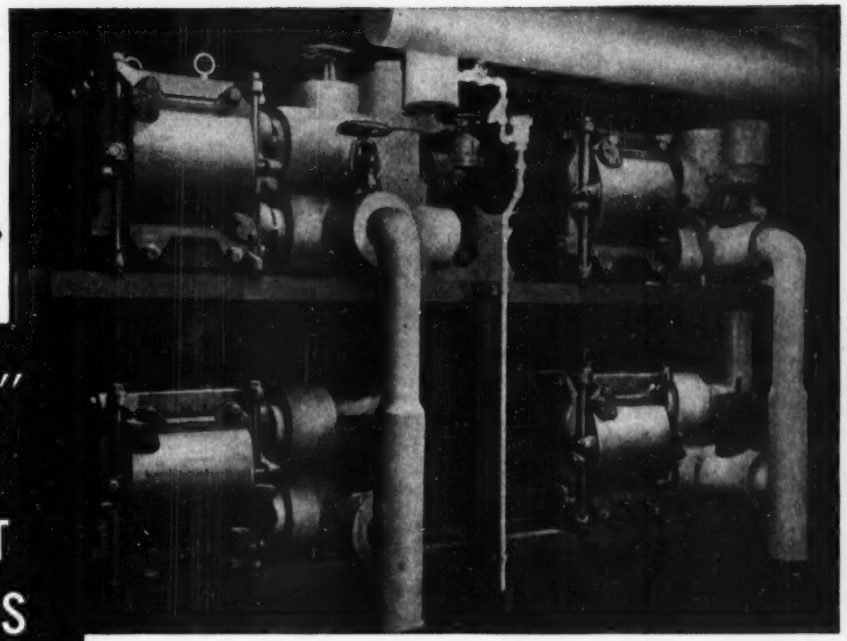
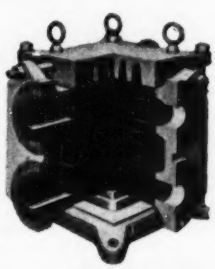
Whether it be the fast game and the cool drink, the hearty meal and the short nap, or the quick dip and the sun-bath, it's the combination that puts you at ease. And we at Cooper Alloy like to feel that our research and production specialists—our longhairs and our "do"ers form just the combination you need to relax. When stainless steel castings, valves or fittings are in the picture—give us a chance to carry the load for you—Cooper Alloy products are made to serve. Use them with confidence and relax.

One of several batteries of Delanium Cubic Heat Exchangers at Courtaulds (Canada) Limited.



"DELANIUM" GRAPHITE CUBIC HEAT EXCHANGERS

...save space, resist corrosion, and reduce maintenance at Courtaulds (Canada) Limited



In compression at all times, the Delanium Cubic Exchanger can be operated at pressures to 100 psi. Unit is highly versatile and may be adapted to a variety of uses in the chemical and allied industries.

It is being successfully used as a:

- **Heater**
- **Cooler**
- **Condenser**
- **Evaporator**
- **Crystallizer**
- **Interchanger**
- **Reaction Vessel**

CONSIDERATIONS of space, maintenance, and resistance to highly corrosive sulphuric acid liquors resulted in 15 repeat orders for Delanium Cubic Heat Exchangers for various installations at Courtaulds (Canada) Limited, world-famous producers of viscose.

CUBIC DESIGN SAVES SPACE

The high thermal conductivity and compression strength of Delanium graphite makes possible 50 sq. ft. of heat transfer surface in a 15" cube. No other corrosion-resistant exchanger offers the same area-to-volume ratio.

RESISTS CORROSION

Delanium Exchangers withstand the highly corrosive sulphuric acid liquors widely used in the manufacture of viscose. Actually, the dense, impervious Delanium graphite resists the attack of most acids, alkalies, salt solutions and organic chemicals.

REDUCES MAINTENANCE

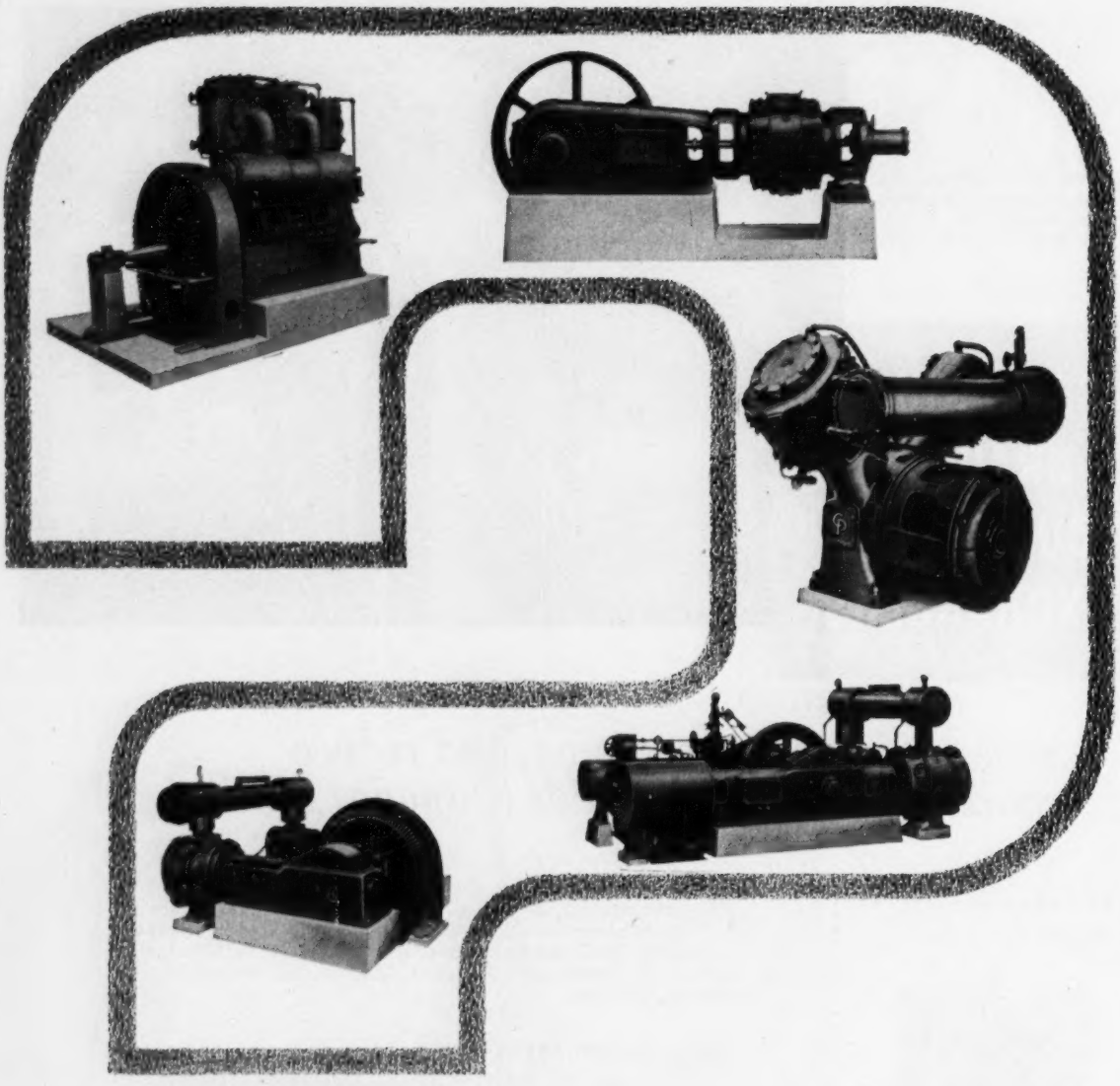
Cubic construction eliminates the breakage hazards present when handling fragile tube bundles. Headers are easily removed for inspection and cleaning.

These are but a few of the *many* advantages of Delanium Graphite Cubic Heat Exchangers. For complete descriptive material write Delanium Carbon Corporation, 18 East 48th St., New York 17, N. Y.

"Delanium"

Trade Mark

A Subsidiary of Great Lakes Carbon Corporation

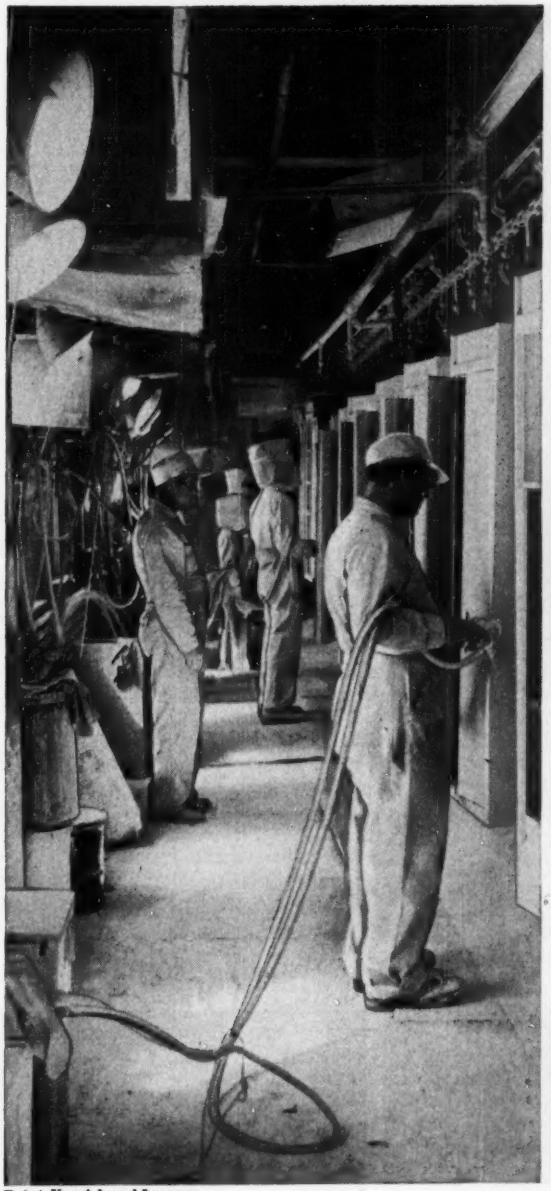


WHAT DO YOU WANT IN A COMPRESSOR?

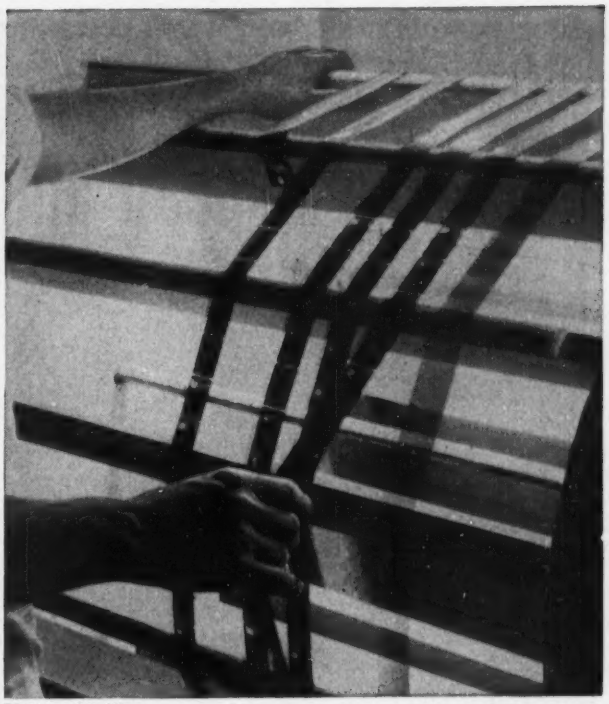
Whatever your requirements, there's a CP Compressor to fulfill your air needs at minimum operating and maintenance costs. Whether the type is portable or stationary . . . single-stage or multi-stage . . . lubricated or oil-less cylinder . . . vertical or horizontal . . . air-cooled or water-cooled . . . for air or gas compression, you can select from Chicago Pneumatic's wide line of compressors. Capacities range from 60 to 10,000 cfm., 7½ to 2000 hp. For complete information on the type compressor you have in mind, write *Chicago Pneumatic Tool Company, 8 East 44th Street, New York 17, N. Y.*

Chicago Pneumatic

PNEUMATIC TOOLS • AIR COMPRESSORS • ELECTRIC TOOLS • DIESEL ENGINES • ROCK DRILLS • HYDRAULIC TOOLS • VACUUM PUMPS • AVIATION ACCESSORIES



Paint, Varnish and Lacquer



Photographic Films

Heavy-duty Motor Oils (additives)

Success in the process! They all rely on ENJAY

for a complete line of high quality petroleum chemicals

PETROLEUM

PARANOX
PARATONE
PARAFLOW
PARAPOID
PARADYNE
PARATAC
PETROHOL
Methyl Ethyl Ketone
Dewaxing Aid
Ethyl Ether
Isopropyl Ether
Reference Fuels

SURFACE COATING

PETROHOL 91
PETROHOL 95
PETROHOL 99
JAYSOL
Secondary Butyl Alcohol
Secondary Butyl Acetate
Isopropyl Acetate
Acetone
Methyl Ethyl Ketone
Ethyl Ether
Isopropyl Ether
Dicyclopentadiene
Napththenic Acids
Iso-Octyl Alcohol
Decyl Alcohol
Denatured Ethyl Alcohol

CHEMICAL

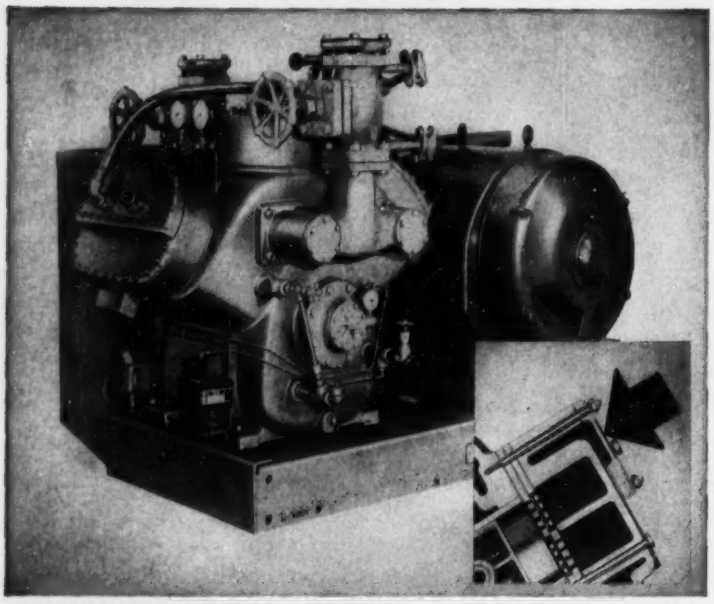
PETROHOL 91
PETROHOL 95
PETROHOL 99
JAYSOL
Iso-Octyl Alcohol
Decyl Alcohol
Denatured Ethyl Alcohol
Tridecyl Alcohol
Dicyclopentadiene
Isoprene
Butadiene
Ethyl Ether
Isopropyl Ether
Tetrapropylene
Tripropylene
Aromatic Tars
Benzene
Acetone
Methyl Ethyl Ketone

34 successful years of leadership in serving industry

To get proved results rely on a leader. The Enjay Company offers a wide variety of chemicals, backed up by 34 years of pioneering, research and experience. More and more industries in many different fields are depending on Enjay for successful results. Be sure you specify Enjay for *your* chemical needs.

ENJAY CO., INC. • 15 West 51st Street, New York 19, N. Y.

Look at all the features of Worthington's new high-speed ammonia compressor



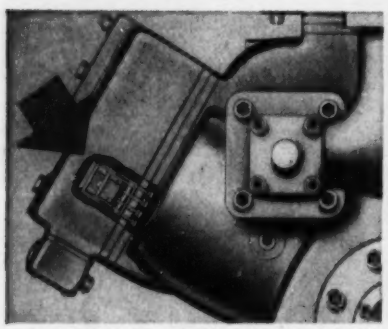
IMPROVED INTERNAL MANIFOLDING—cool suction gas completely surrounds the cylinder walls, providing longer valve life and increased overall efficiency. All passageways between suction discharge and shutoff valves are cast integrally within the crankcase, eliminating outboard fittings. Cross section shows water jacketing on one of the cylinders.

High operating efficiency and lighter weight make this modern unit the talk of the industry

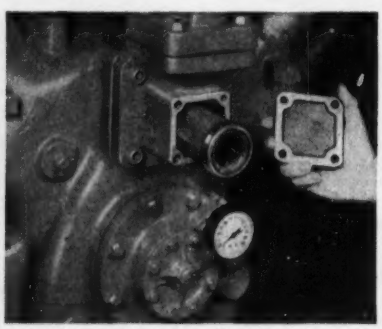
These lightweight, compact Worthington ammonia compressors have the same high operating efficiency and versatility as their lower speed counterparts.

Ranging in capacities from 18 to 150 tons, the new units can be used as high-stage or booster machines.

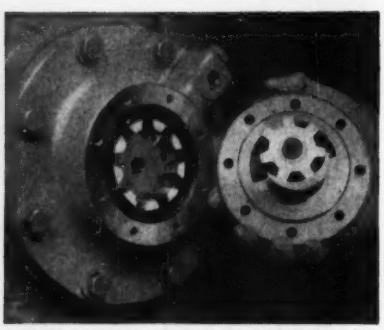
Get in touch with your nearest Worthington district office for more facts about these rugged compressors. Or write to Worthington Corporation, Air Conditioning and Refrigeration Division, Section A.3.56, Holyoke, Mass.



ELECTRIC UNLOADING—a new achievement in variable capacity control. You can start compressor with a normal torque motor; power consumption is automatically balanced against load. Separate unloader units allow easy maintenance . . . no oil or gas pressure lines to worry about.



NEW SUCTION MANIFOLD, with cover plate over suction strainer inlet, allows easy removal of the suction gas strainer for cleaning, without disturbing any of the pipes, valves or other parts. The strainer is unique in that it fits entirely within the crankcase manifold, requiring no additional space.

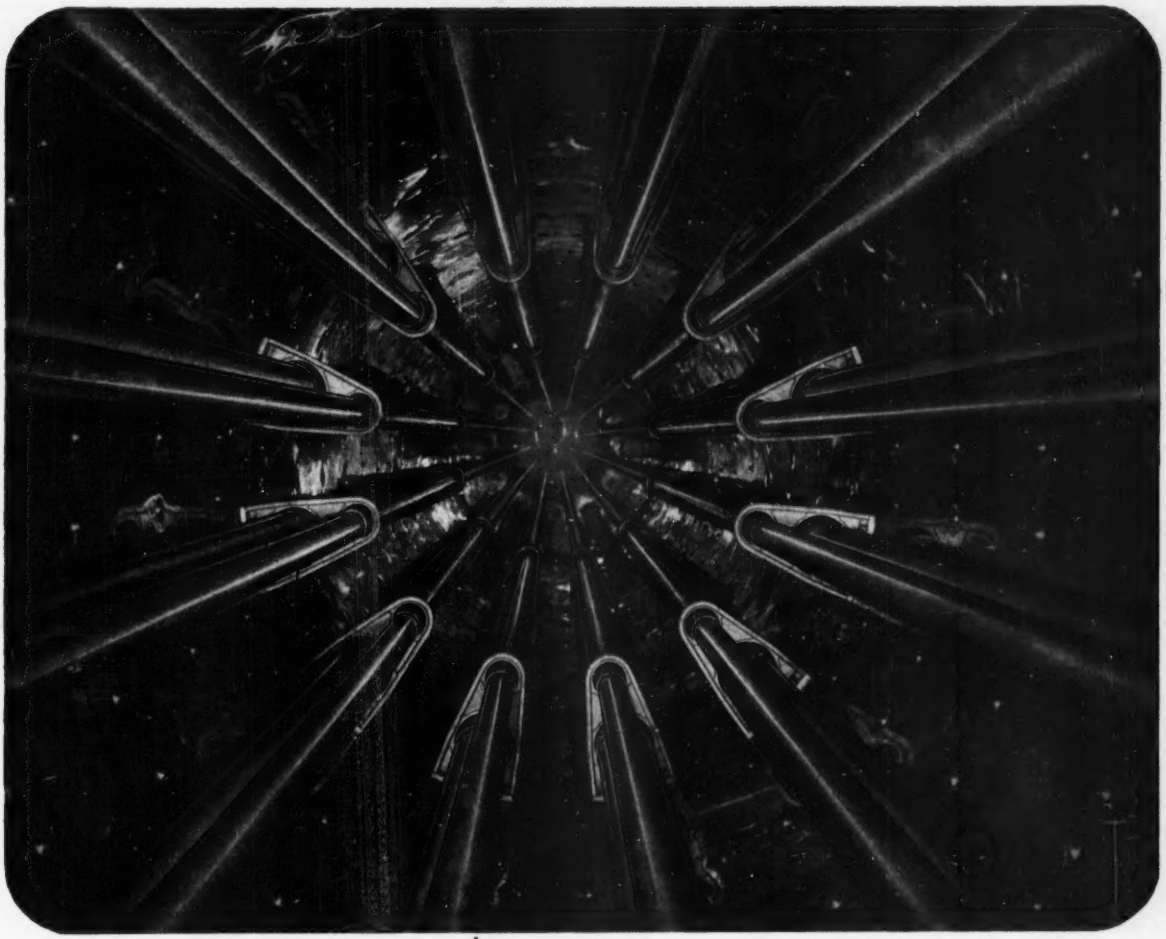


NEW FORCE-FEED LUBRICATION SYSTEM — full pressure, positive lubrication, regardless of rotation. A new rotary oil pump, driven directly by the crankshaft, eliminates complicated and noisy gear trains. Oil is filtered through a strainer in the crankcase for protection of pump and other moving parts.

A.3.56

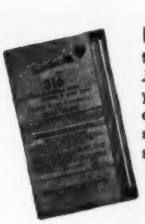
WORTHINGTON

CLIMATE ENGINEERS TO INDUSTRY, BUSINESS AND THE HOME



TRENTWELD STAINLESS TUBING

gives longer operating life...



FREE—Write for your copy of the new TRENTWELD price calculator. Just a tug at the selector slide gives you complete price information and weight per foot of the tubing size and grade you need. Better send for your free copy now.

TRENTWELD stainless steel tubing gives economical, trouble-free service over long periods of use. It's an ideal choice, for example, for applications such as the 60-foot rotary kiln dryer you are looking into in the photograph above . . . operating at high temperatures and where corrosive conditions are encountered.

In fact, you just can't buy better tubing than TRENTWELD for any application. That's because TRENTWELD stainless and high-alloy *welded* tubing is a product of tube mill specialists. Each tube has a uniformly sound weld indistinguishable from the parent metal and just as strong and corrosion-resistant.

Whether or not your job is as large and complex as a rotary dryer, you can specify TRENTWELD tubing with confidence. And when it comes to tubing sizes and finishes, Trent offers the widest range in the industry . . . from ⅛" to 40" O.D. and up. Next time you have a job involving tubing, remember—you can make it better with TRENTWELD.

TRENTWELD

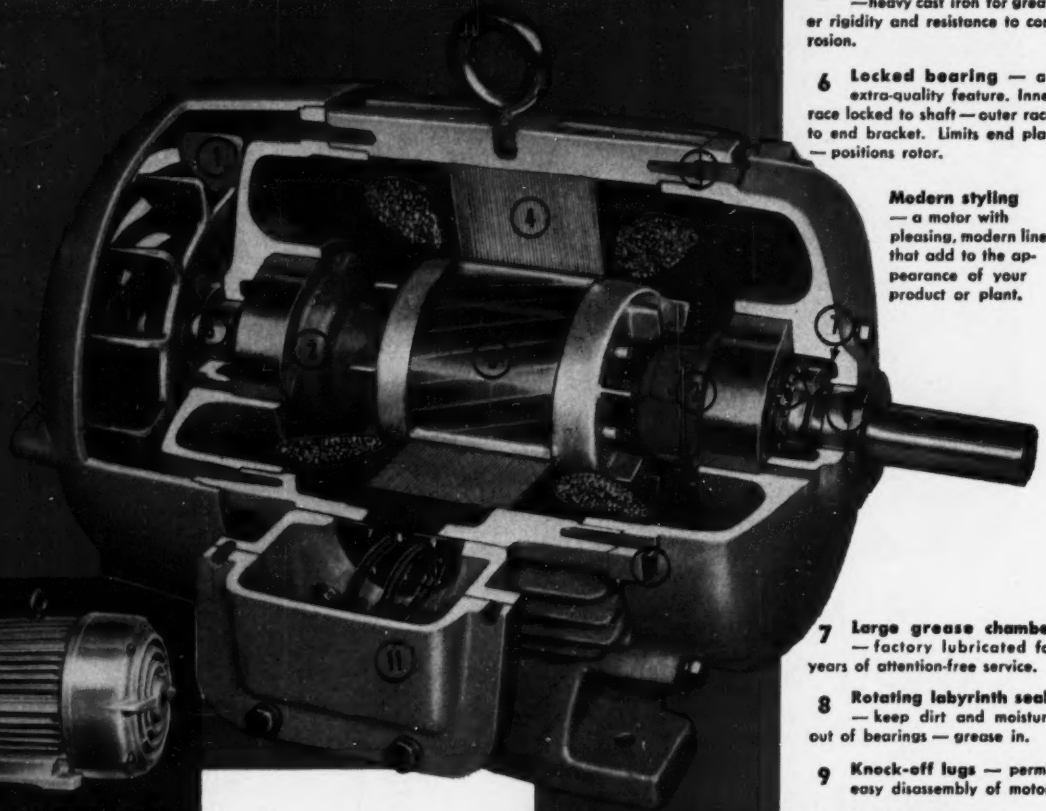
STAINLESS STEEL TUBING

TRENT TUBE COMPANY, GENERAL SALES OFFICES, EAST TROY, WISCONSIN (Subsidiary of CRUCIBLE STEEL COMPANY OF AMERICA)

Here's the inside story of

the NEW L.A. *Line*

...your BEST enclosed and explosion-proof motor BUY



1 Fan — efficient, non-sparking fan. New aerodynamic design for more effective cooling.

2 Inner bearing cartridges — lock bearings to end bracket and form explosion-quenching seal along shaft.

3 Indestructable cast-aluminum rotor—dynamically balanced with fan for smooth, quiet operation.

4 Stator — prewound stator core utilizes Formvar wire insulated with a new Alkyd Asphalt Resin insulating varnish.

5 End bracket and housing —heavy cast iron for greater rigidity and resistance to corrosion.

6 Locked bearing — an extra-quality feature. Inner race locked to shaft — outer race to end bracket. Limits end play — positions rotor.

Modern styling — a motor with pleasing, modern lines that add to the appearance of your product or plant.

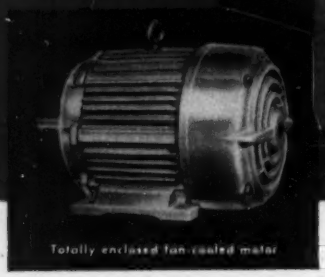
7 Large grease chamber — factory lubricated for years of attention-free service.

8 Rotating labyrinth seals — keep dirt and moisture out of bearings — grease in.

9 Knock-off lugs — permit easy disassembly of motor.

10 Lead identification—permanent, positive lead identification spacer in conduit box.

11 New split conduit box — rugged cast-iron conduit box diagonally split for easy connection.

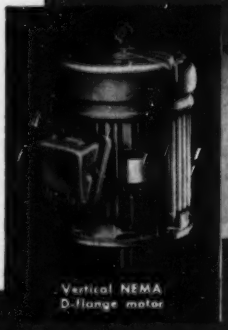


Totally enclosed fan-cooled motor

This is the completely new L.A. totally enclosed fan-cooled and explosion-proof motor. Every feature in this new line is designed for easier installation, longer service life, less maintenance and attention. You get the full benefit of the new NEMA standards in a smaller, more functional, completely modern design.

Your nearby Louis Allis Sales Engineer can show you all the reasons why these motors perform better and longer on your tough jobs — why they give you maximum resistance to corrosion wherever you need this extra protection. Call him today.

THE LOUIS ALLIS CO.
MILWAUKEE 7, WISCONSIN

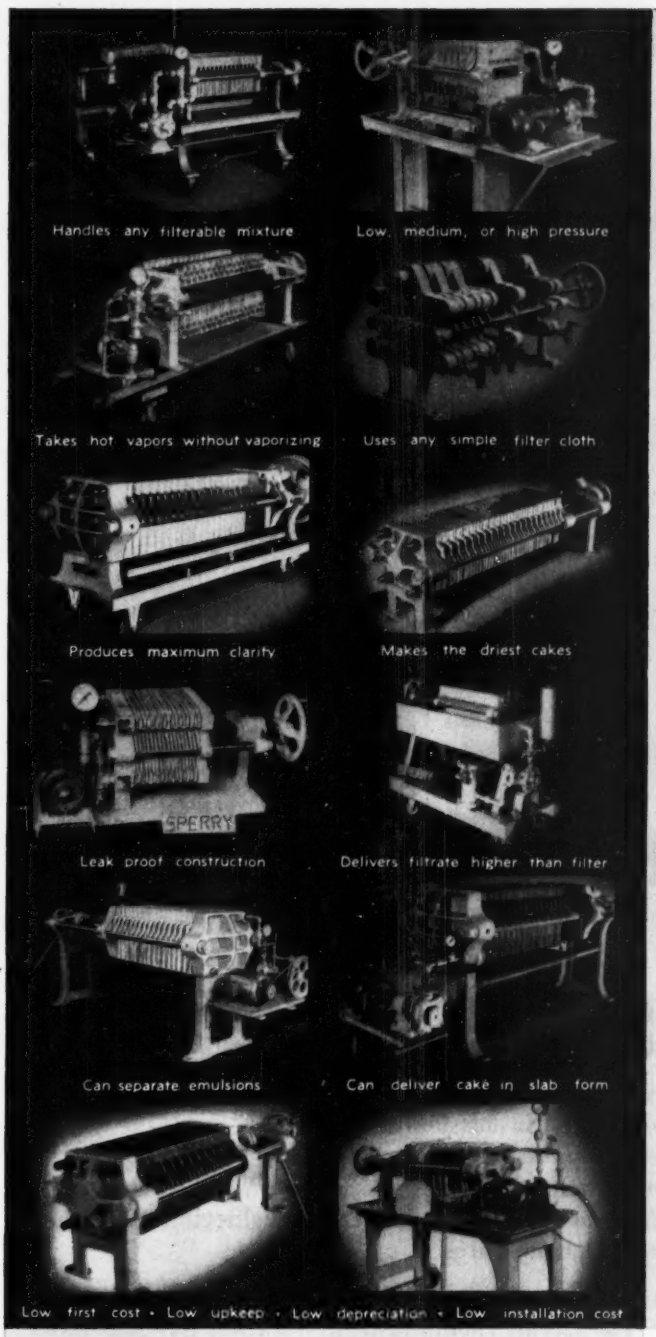


Vertical NEMA D-flange motor

NEMA C-flange motor

NEMA D-flange motor

We specialize in SPECIAL MOTORS — *and* PROMPT DELIVERY, TOO


Handles any filterable mixture
Low, medium, or high pressure
Takes hot vapors without vaporizing
Uses any simple filter cloth
Produces maximum clarity
Makes the driest cakes
SPERRY
Leak proof construction
Delivers filtrate higher than filter
Can separate emulsions
Can deliver cake in slab form
Low first cost • Low upkeep • Low depreciation • Low installation cost

THOUSANDS of SPERRY FILTER PRESSES

serving HUNDREDS of industries . . .

built to ONE standard of quality!

In *every* processing industry — *wherever* solids are to be removed from *any* mixture — Sperry Filter Presses are on the job . . . helping to produce products of maximum clarity at low cost. Living proof of the detailed research, custom engineering and standard of quality that has kept Sperry *first in filtration* for three generations.

If you can utilize the significant knowledge gained from this vast experience — consult *Sperry for filtration, today!*

SPERRY FILTER BASES

All types . . . all sizes. Plain or punched to your specifications. Besides cotton and paper, bases are furnished in wool, synthetics, glass, and woven metals.

NEW SPERRY Catalog & Specification Book *NOW AVAILABLE!*

Written more as a text and reference manual, this "encyclopedia of filtration data" improves your understanding of a vital process; aids in the selection of the proper equipment for your specific filtration requirements. Write for your *free* copy of this valuable booklet — today!

D. R. SPERRY & CO.

BATAVIA, ILLINOIS

Filtration Engineers for More Than 60 Years

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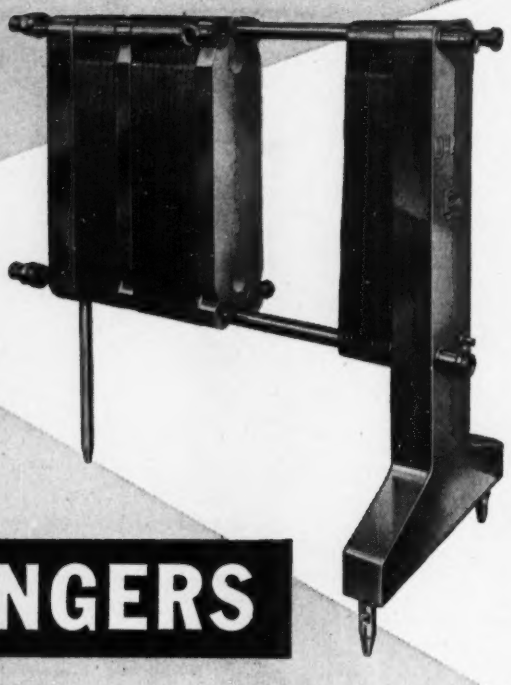
LOOK TO DE LAVAL FOR HEAT EXCHANGERS ...as Well as Centrifugals



De Laval Plate Heat Exchangers are designed with the engineering "know-how" and manufactured to the same high standards of precision as De Laval Centrifugals, and offer these advantages:

Unsurpassed heat transmission
All heat-transmitting surfaces readily accessible for inspection and cleaning
Easy variation of assembly to meet changes in operation
Ease of assembly and disassembly—special design for precision tightening
Withstand high pressures

De Laval Bulletin PHX shows exactly how De Laval Plate Heat Exchangers are constructed and describes the De Laval Vacuum-Steam Heating System for closest possible temperature control. *Write for it.*

THE DE LAVAL SEPARATOR COMPANY
Poughkeepsie, New York • 427 Randolph St., Chicago 6 • DE LAVAL PACIFIC CO., 61 Beale St., San Francisco 5

DE LAVAL
PLATE HEAT EXCHANGERS

A highly reactive chemical intermediate

Jefferson ETHYLENE OXIDE

Produced by *specialists* in "essential chemicals from hydrocarbon sources."

Made to traditional high standards of quality, Jefferson's Ethylene Oxide is used as a starting material in the manufacture of acrylonitrile and nonionic surface active agents, and as a sterilizing agent and fumigant. It is in general a very reactive chemical intermediate.

Available immediately in 4,000 and 10,000-gal. tank cars and 400-lb. net (ICC 5 P) drums. Samples for your preliminary investigation.

Jefferson
CHEMICAL COMPANY, INC.
260 MADISON AVENUE, NEW YORK 16, N.Y.

Branch Sales Offices: Chicago, Houston, Charlotte
West Coast Sales Agent: Nelson A. Howard, Jr., Los Angeles
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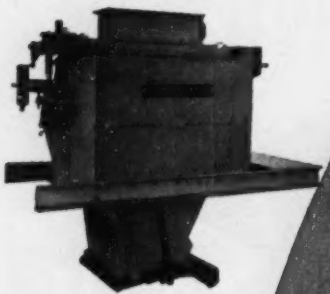
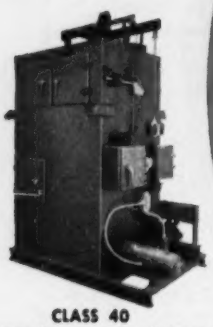
Ethylene Oxide,
Glycols, Dichloride
Ethanolamines
Nonyl Phenol
Morpholine
Ethylene Carbonate
Propylene Carbonate
Polyethylene Glycols
Glycol Ethers

what can WE do for YOU Mr. Processor?

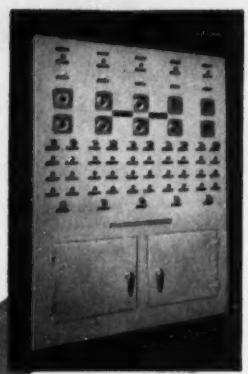
CLASS 50
Dust-tight, all-electric, high-speed, accuracy-indicating scale for weighing dry, ground, granular, dusty, non-free-flowing and some small lumpy materials. Bulletin 3649.



CLASS 38
Dust-tight, heavy-duty scale for dry, ground, dusty, non-free-flowing materials. Bulletin 8946.



CLASS 40
Accommodates screw, belt, or vibrating feeder for handling wide range of materials. Dust-tight, solenoid- or motor-operated discharge, accuracy-indicating. Bulletin 1449.



CONTROL PANEL
Richardson-designed panels such as this control whole automatic weighing systems composed of scales like those at the left.

Frankly, that's the reason we're running this ad—not to tell you about our products, but to ask you about your plant problems. Because if your business involves the handling of any materials or liquids by weight, we think you probably have an operation or two which just doesn't measure up in efficiency, economy, or speed. We'd like to know about it, because we think we can help.

You can call it pride, or conceit, or self-satisfaction, or self-confidence, but our engineers have never been stumped for long by a problem in materials-handling by weight—and in fifty years of working with the biggest names in American industry we've seen a lot of them! From aluminum sulphate, to zinc oxide, and back to almonds we've successfully installed Richardson units or systems to handle just about everything in the book, and built a lot of goodwill and a fair-size company in the process.

Naturally, if a Richardson Scale can contribute to the smoother, faster, or more profitable operation of your plant, we'd like to sell you one. We think that our products and experience can help in solving your problem in processing, and if you'll outline it, we'll be glad to have one of our field engineers arrange to go over it with you.

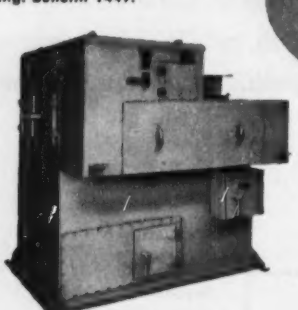
Or, if you'd just like to know more about Richardson Scales for possible future reference, simply clip this ad to your signed letterhead and mail. Bulletins 0450, 0550, and 0351 will be sent you by return mail—no obligation.

The Richardson Scale Company, Clifton, N. J., will be glad to supply information on:

Feeder-Weigher Systems • Automatic Bulk Weighing Hopper Scales • Automatic Bagging Scales • Bag Sewing Conveyors Packers • Process Control Panels and Select-O-Weigh

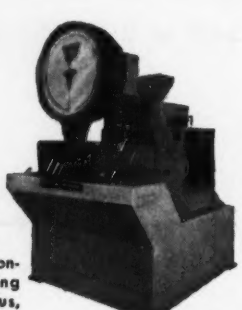
Please write direct to our Clifton office, or to the nearest of our branch offices located in Atlanta, Boston, Buffalo, Chicago, Detroit, Houston, Memphis, Minneapolis, New York, Omaha, Philadelphia, Pittsburgh, San Francisco, Wichita, Montreal, Toronto, Havana, Mexico City, San Juan.

Richardson
MATERIALS HANDLING BY WEIGHT SINCE 1901



CLASS 39
Self-contained, dust-tight, belt-feeding and weighing unit. Accuracy-indicating for process or intermittent batch weighing of lumpy, crushed, sluggish materials. Bulletin 1549.

CLASS 56
Self-checking, automatic feeder-weigher for large tonnage; practically continuous stream delivery. Beam system has approval of all weighing authorities. Bulletin 2140-2.



SELECT-O-WEIGH
On electronic weight control system providing remote, instantaneous, dial-control formula changing and ingredient selection for all proportioning applications. Bulletin 0351.

8369

PROCESS EQUIPMENT NEWS

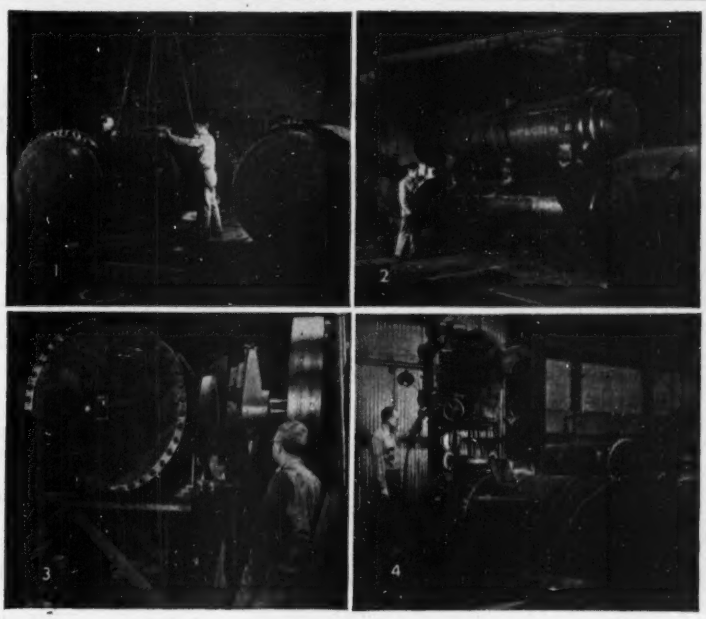
PUBLISHED BY FABRICATED PRODUCTS DIVISION, THE M. W. KELLOGG COMPANY AUGUST-SEPTEMBER 1954

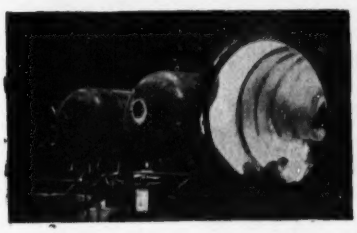
Five Giant Reactors For High Octane Gasoline Plant

In this impressive line-up in Kellogg's Jersey City, N. J., shops (below) are shown four of five identical pressure vessels currently being fabricated for a large Midwestern refiner of petroleum.

When completed, these giants will function as the reactors for a fixed bed catalytic reforming unit —a process that reforms low grade naphthas into high octane gasoline through the use of a platinum catalyst and high temperatures and pressures.

Each of the reactors is 9 feet in internal diameter by 10 feet





3 inches in length. To withstand internal operating conditions of more than 1000°F. and nearly 400 pounds pressure, they are constructed of carbon moly steel, 1-7/16 inches in thickness. When completed, each vessel will tip the scales at 39,000 pounds.

FABRICATED PRODUCTS DIVISION

M. W. KELLOGG COMPANY

KELLOGG PULLMAN

Extra Care in Stacking Exchangers Pays Off in Trouble-Free Operation

When an exchanger consists of two or more sections, with shell and tube fluids flowing in series, it is frequently possible to save space, piping, and supporting steel by stacking the units nozzle-to-nozzle. Kellogg, in the course of its 30 years experience in manufacturing exchanger equipment, has developed a number of special techniques for stacking units whenever this arrangement is called for which assure precise alignment of nozzles, easy assembly, and trouble-free operation.

The photographs above show a sequence in just one of the precautionary operations Kellogg uses to assure proper alignment of nozzles in two vertically stacked units. Normal manufacturing and assembly tolerances for nozzle locations, height of nozzles, and angular alignment have of course been taken into consideration in these sections.

At the start of the operation, both units have been inspected and tested hydraulically. With the shell and channel nozzles of one section left unmachined and undrilled, the two units are stacked in the shop (Photos 1 and 2). In this position, the top unit is leveled, supports are shimmed as required, and the nozzles are laid out for facing and drilling to match the nozzles of the lower one which were faced and drilled prior to welding into the unit.

After determining the alignment, machining requirements, and placement of flange holes on the unfinished section, it is taken down and set up in a boring mill (Photo 3) where the nozzle flanges are faced. In the final operation (Photo 4), flanges are drilled according to the layout determined while the units were stacked.

By following this careful procedure in the shop, Kellogg can assure perfect matching of the units when they reach the field. Final assembly is thus made easier, and chances of leaks, once the stacked exchangers are in operation, are reduced to a minimum.

It's the Nash!

The ability of Nash Compressors to maintain original performance over long periods is no accident. Nash Compressors have but a single moving element, the Nash Rotor. This rotor is precision balanced for long bearing life, and it revolves in the pump casing without metallic contact. Internal lubrication, frequent cause of gas contamination, is not employed in a Nash. Yet, these simple pumps maintain 75 lbs. pressure in a single stage, and afford capacities to 6 million cu. ft. per day in a single compact structure.

Nash Compressors have no valves, gears, pistons, sliding vanes or other enemies of long life. Compression is secured by an entirely different principle of operation, which offers important advantages often the answer to gas handling problems difficult with ordinary equipment.

Nash Compressors are compact and save space. They run without vibration, and compression is without pulsation. Because there are no internal wearing parts, maintenance is low. Service is assured by a nation-wide network of Engineering Service offices. Write for bulletins now.

No internal wearing parts.

No valves, pistons, or vanes.

No internal lubrication.

Low maintenance cost.

Saves floor space.

Desired delivery temperature Automatically maintained.

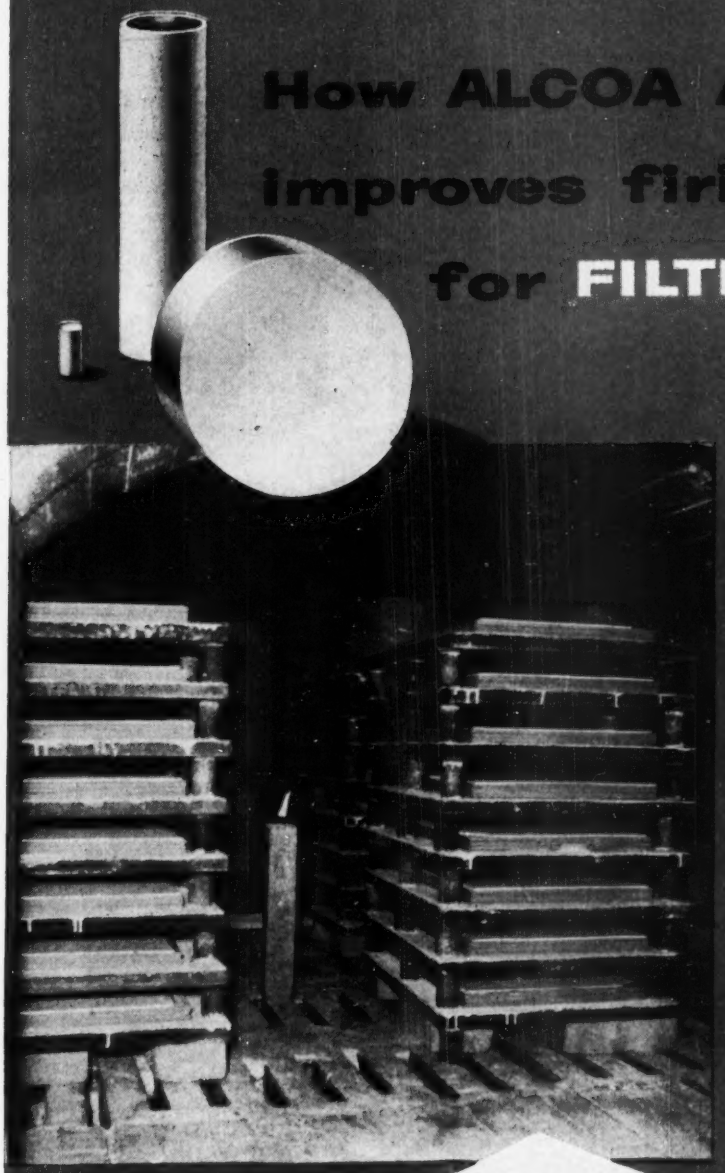
Slugs of liquid entering pump will do no harm.

75 pounds in a single stage.

NASH ENGINEERING COMPANY

312 WILSON, SO. NORWALK, CONN.

How ALCOA ALUMINA improves firing results for FILTROS, INC.



Muffle slabs at Filtros using Alcoa Alumina-fortified slabs and saggers manufactured by Richard C. Ramsey Son Co., Philadelphia.

For more than five years, Filtros, Inc., East Rochester, N.Y., has used ALCOA Alumina as a basic raw material in the manufacture of electrolytic diaphragms. They've found that ALCOA Alumina prevents "moving" in firing, reduces shrinkage to a minimum. Moreover, the plates do not crack even with moderate jumps in the firing cycle. ALCOA Alumina further assures the low electrical resistance required from an electrolytic diaphragm.

ALCOA Alumina is also used to fortify the slabs and saggers used in firing at Filtros. Alumina-fortified slabs last longer than ordinary slabs . . . increase load-bearing strength . . . reduce costs.

This is typical of how ALCOA Aluminas are used to improve products and reduce manufacturing costs. These versatile aluminum oxides enable *refractories* to withstand higher temperatures and last longer . . . improve the dielectric strength of *insulators* . . . increase thermal and mechanical shock resistance in *glass and ceramic products*.

For complete details and experimental samples, write to ALUMINUM COMPANY OF AMERICA, CHEMICALS DIVISION, 702-J Alcoa Building, Pittsburgh 19, Pa.

ALCOA CHEMICALS

ALUMINUM COMPANY OF AMERICA

UNICHROME
Trade Mark

News about
COATINGS for METALS
Metallic . . . . . Organic . . . . . Decorative . . . . . Protective

New corrosion-control "tool" provided by spraying-type plastisol

Ucilon Protective Coatings solve many problems

A variety of Ucilon* Protective Coating Systems, using either air-drying or baking coatings are available to handle problems that cannot be solved with plastisols. Applied like ordinary paint, Ucilon Coating Systems resist the same corrosives as plastisols and even some that plastisols do not withstand. The line includes systems based on vinyl, phenolic, chlorinated rubber and other chemical resisting coatings. Detailed information is provided in Bulletin MC-8. Send for it – no obligation.

*Trade Mark

Four types of drum linings handle most needs

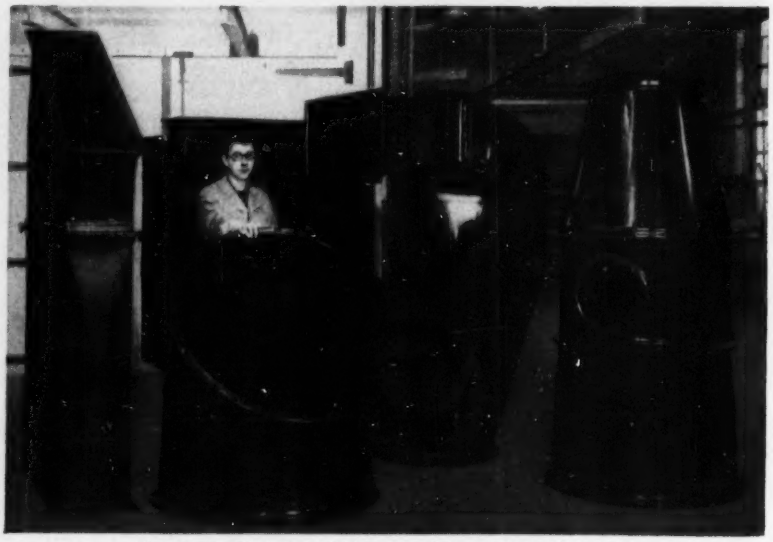
Protection against drum corrosion and contamination of product is being obtained by many major steel drum suppliers by four basic types of Unichrome Drum Linings.

These include: (1) Phenolic base linings which are well suited for packaging solvents, oils, acid products and are used extensively in shipping detergents. (2) An epoxy resin base lining that not only gives essentially the same chemical resistance as the phenolics but also better flexibility and alkali resistance. (3) Vinyl base linings which are used effectively for packaging foods as well as caustics, latex, potable mineral oils and the like. (4) Plastisol drum linings which resist a wide range of products and are good for multiple trips.

Bulletin DL-2 gives you more details.

UNITED CHROMIUM, INCORPORATED
100 East 42nd Street, New York 17, N. Y.
Detroit 20, Mich. • Waterbury 20, Conn.
Chicago 4, Ill. • Los Angeles 13, Calif.
In Canada:
United Chromium Limited, Toronto 1, Ont.

Unichrome Series 5300 Plastisols protect equipment with single coats up to 25 mils thick



These fume control ducts, better equipped to resist corrosion, typify the large areas which can now be protected with Unichrome Plastisols.

ANY metal surface that can be sprayed and uniformly baked can now be protected against severe corrosive conditions with vinyl plastisol. Development of Unichrome Series 5300 Plastisols, the first practical sprayable plastisols, offers engineers the solution to many chemical corrosion problems.

UNUSUAL PROTECTION

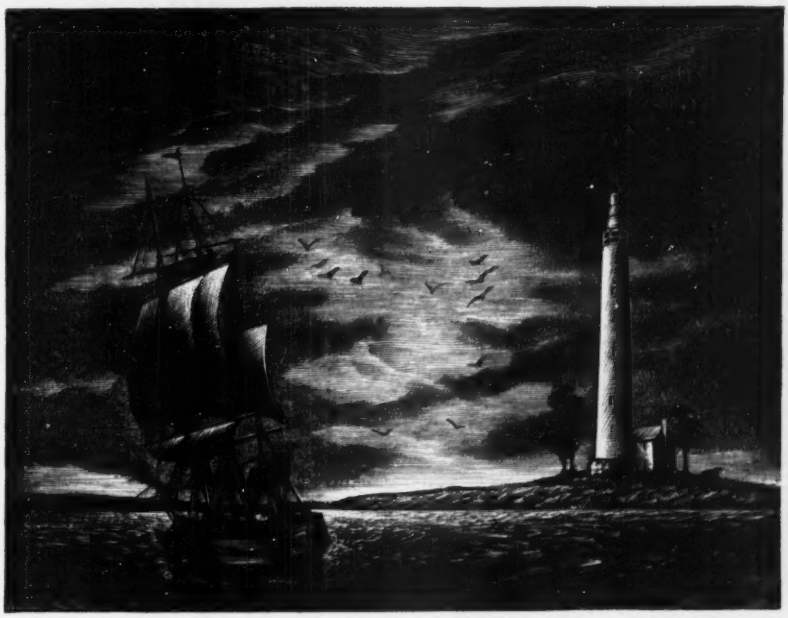
Unichrome Series 5300 Plastisols have many advantages over ordinary coatings. They offer continuous, seam-and pore-free protection against a wide variety of corrosives, including acids, alkalies, water, salt solutions, oxidants, reducing agents, and many others. They level surface irregularities and provide substantially greater protective film thickness, features particularly important in coating surfaces that are not smooth. 5300 Plastisols are resilient, resist abrasion, chipping and cracking. Single coat dry film thicknesses up to 25 mils can be obtained.

ASSISTANCE IN SOLVING PROBLEMS

United Chromium, with its unequalled experience in the plastisol field, provides detailed recommendations on solving corrosion problems with plastisols. Interested engineers need only provide details of their problems. The company can also provide the names of coating specialists qualified to apply plastisols to your equipment.

More information about Unichrome Series 5300 Plastisols may be obtained by sending for Bulletin VP-1.

FAMOUS LIGHTHOUSES OF AMERICA



Boston Light, America's first lighthouse, was built in 1716 at the north side of the entrance to the main ship channel in Boston Harbor. The scene of several bitter contests for possession during the Revolutionary War, it was destroyed by the British in 1776. A new tower for this famous light was built in 1783 and is still in use today.

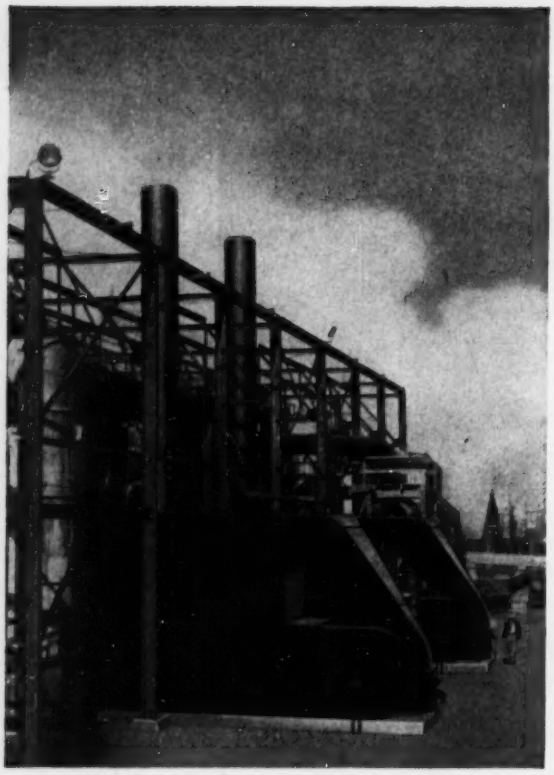
Guiding Light to users of electrochemicals is the integrity of Niagara Alkali Company, for over fifty years a pioneer in the development and production of these important materials. You can rely on Niagara for quality in...

Nialk® Liquid Chlorine, Nialk Caustic Potash, Nialk Carbonate of Potash, Nialk Paradichlorobenzene, Nialk Caustic Soda, Nialk TRICHLORethylene, Niagathal® (Tetrachloro Phthalic Anhydride)

NIAGARA ALKALI COMPANY

60 East 42nd Street, New York 17, N. Y.

How to get rid of industrial fumes



American Blower Fans help get rid of fumes in this catalytic fume disposal installation at a modern chemical plant.

Revolutionary, new Catalytic Combustion process uses American Blower Fans to help convert hazardous industrial fumes to odor-free, color-free gases

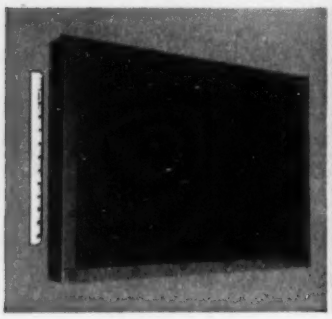
An ingenious, low-temperature oxidation process developed by the Catalytic Combustion Corporation, Detroit, Michigan, uses American Blower Fans to help convert organic industrial fumes into odorless, colorless (and harmless!) gases – plus useful heat energy.

The secret of this fume-destroying system is the Suter-Ruff Catalytic Element: a closely packed mat of heat- and corrosion-resistant metallic ribbons, coated with platinum alloy, and conditioned to produce catalytic action.

Catalytic Combustion occurs when burnable fumes are passed through this catalytic element. Fume destruction is complete, whether fumes are present in traces or heavy concentrations.

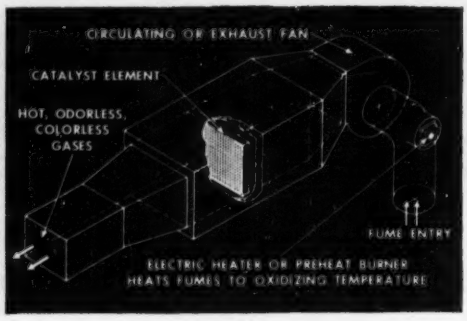
Good velocity and distribution of fumes through the mat is a *must* for effective use of the entire catalyst area. Catalytic Combustion Corporation relies on American Blower Fans in its installations to do this important job; they've found that American Blower Fans are efficient, long lived, quiet in operation.

If *you* have an air-handling problem, feel free to call on American Blower engineers – any time. Just phone your nearest American Blower or Canadian Sirocco Branch Office.



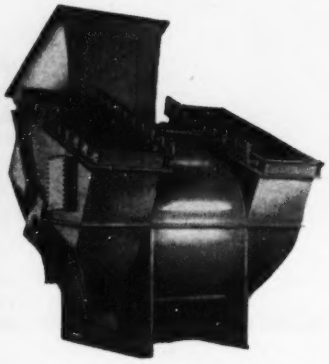
Suter-Ruff Catalytic Element

Small in size, the Suter-Ruff Catalytic Element is capable of handling large volume. During fume oxidation, temperatures jump as much as 600° F. – furnishing heat that may be utilized in manufacturing.


CIRCULATING OR EXHAUST FAN
CATALYST ELEMENT
HOT, ODORLESS, COLORLESS GASES
FUME ENTRY
ELECTRIC HEATER OR PREHEAT BURNER HEATS FUMES TO OXIDIZING TEMPERATURE

The Catalytic Combustion Process

For catalysis to take place, fumes must be preheated with an electric heater or preheat burner. American Blower fans provide the needed mixing, circulation and exhaust of fumes at elevated temperatures. Catalytic Combustion eliminates fire hazards, condensate in ducts, air pollution.



Sirocco Induced Draft Fan

American Blower Fans are used extensively for forced and induced draft, ventilating, air conditioning, drying, fume removal, and processing systems. Write to us for Literature on our complete line of products.

AMERICAN BLOWER CORPORATION, DETROIT 32, MICHIGAN • CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO
Division of American Radiator & Standard Sanitary Corporation

YOUR BEST BUY AMERICAN BLOWER AIR HANDLING EQUIPMENT

Serving home and industry: AMERICAN-STANDARD • AMERICAN BLOWER • CHURCH SEATS & WALL TILE • DETROIT CONTROLS • KEWANEE BOILERS • ROSS EXCHANGERS • SUNBEAM AIR CONDITIONERS

BAD AIR IS COSTLY...

... as compared to the blower that keeps air fresh

Your men can't produce at top efficiency when stagnant, hot or fume-filled air robs them of their energy.

Wherever bad air slows down production . . . in shipholds, tanks, drums, boilers or other places where men need fresh, cool air . . . a Coppus Blower becomes both a safety device and a production tool.

Portable and easily adaptable for special purposes, Coppus "Blue Ribbon" Blowers and Exhausters fit all your "fresh air" requirements. The Coppus "Blue Ribbon" means premium performance at ordinary cost. Check and mail the coupon for specific information. Sales offices in THOMAS' REGISTER. Other "Blue Ribbon" Products in CHEMICAL ENGINEERING CATALOG, REFINERY CATALOG, BEST'S SAFETY DIRECTORY, MINING CATALOGS.

OTHER
COPPUS
"BLUE RIBBON"
PRODUCTS

HORIZONTAL TURBINE
Six frame sizes—
1 to 150 horsepower

VERTICAL TURBINE
Six frame sizes—
1 to 150 horsepower

FANMIX GAS BURNER

FANMIX GAS-OIL BURNER

MAIL THIS COUPON To Coppus Engineering Corp., 229 Park Avenue, Worcester 2, Mass.

PLEASE SEND ME INFORMATION ON SUPPLYING FRESH AIR TO MEN WORKING:

- ☐ in tanks, tank cars, drums, etc.
- ☐ in underground cable manholes.
- ☐ in aeroplane fuselages, wings, etc.
- ☐ on coke ovens.
- ☐ on steam-heated rubber processes.
- ☐ on boiler repair jobs.

COOLING:

- ☐ motors, generators, switchboards.
- ☐ wires and sheets.
- ☐ general man cooling.
- ☐ around cracking stills.
- ☐ exhausting welding fumes.
- ☐ stirring up stagnant air wherever men are working or material is drying.
- ☐ drying of walls, sheets; etc., after treated with coating material.

NAME.....

COMPANY.....

ADDRESS.....

CITY.....

(Write here any special ventilating problem you may have.)

EASY TO SERVICE...

a plus value of ASHCROFT *Maxisafe* DURAGAUGES

Turn the knob on the back of the *Maxisafe* and the plate comes off, fully exposing the entire mechanism for fast and easy inspection, recalibration or adjustment. This time and money-saving feature is highly favored wherever Ashcroft *Maxisafe* Duragauges are in service.

This Duragauge was named *Maxisafe* because it has an integrally-cast wall to separate the dial from the movement and Bourdon Tube assembly — a solid wall of safety that protects the viewer if the tube ever ruptures. Covering the back of the case is a double spring mounted safety release plate — a Teflon-coated plate tightly fitted on a rubber gasket and held in place by a knurled knob. Less than 0.5 psi pressure created by a ruptured tube forces this cover open — vents the discharge safely to the rear.

The Maxisafe is available in 4½", 6" and 8½" dial sizes. You can have a choice of standard Ashcroft Duragauge pressure ranges, case designs (except Types 1179 and 1279), and mountings. Get the utmost in sustained accuracy, durability, protection and convenient servicing. Specify Ashcroft *Maxisafe* Duragauges.

YOUR INDUSTRIAL SUPPLY DISTRIBUTOR has complete facts about Ashcroft Gauges of all types. You can depend on his knowledge and experience to help you satisfy every requirement of the application. He maintains local stocks to serve you promptly and economically.

1850 ASHCROFT U.S.A.

ASHCROFT GAUGES

A product of **MANNING, MAXWELL & MOORE, INC.** STRATFORD, CONNECTICUT

MAKERS OF 'ASHCROFT' GAUGES, 'AMERICAN' AND 'AMERICAN-MICROSEN' INDUSTRIAL INSTRUMENTS, 'HANCOCK' VALVES, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, AIRCRAFT PRODUCTS. BUILDERS OF "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES.

"Million Dollar Magic"

Gives Paint a Brighter Future!

The extensive use of titanium pigments in house paint has put a new gleam in millions of homes all over America. Swenson is proud to have contributed to the economical manufacture of titanium pigments through the design and fabrication of suitable evaporator equipment necessary for the satisfactory processing of the titanium solutions. *Many* products—some new, some old—have benefited from Swenson's "magic" boost. This has been confirmed by the manufacturers of viscose rayon, instant coffee, fermentation products, and many other crucial and profitable materials. You may not know *what* possibilities *your* product has until you have talked it over with Swenson *process engineers*. Perhaps Swenson Evaporators, Spray Dryers, Crystallizers, or Filters . . . plus *Swenson know-how* . . . can open new million-dollar markets for *you*. Discuss your product with a Swenson engineer now!

SWENSON EVAPORATOR COMPANY
15669 Lathrop Avenue, Harvey, Illinois

SWENSON
A Division of WHITING Corporation
SINCE 1919

Whiting Corporation Manufactures:

OVERHEAD CRANES

TRAMBEAM

HOISTS

TRACKMOBILES

ELECTRIC FURNACES

TRAIN WASHERS

EVAPORATORS AND SPRAY DRYERS

. . . AND MANY OTHER PRODUCTS FOR SCORES OF INDUSTRIES!

Super Tough

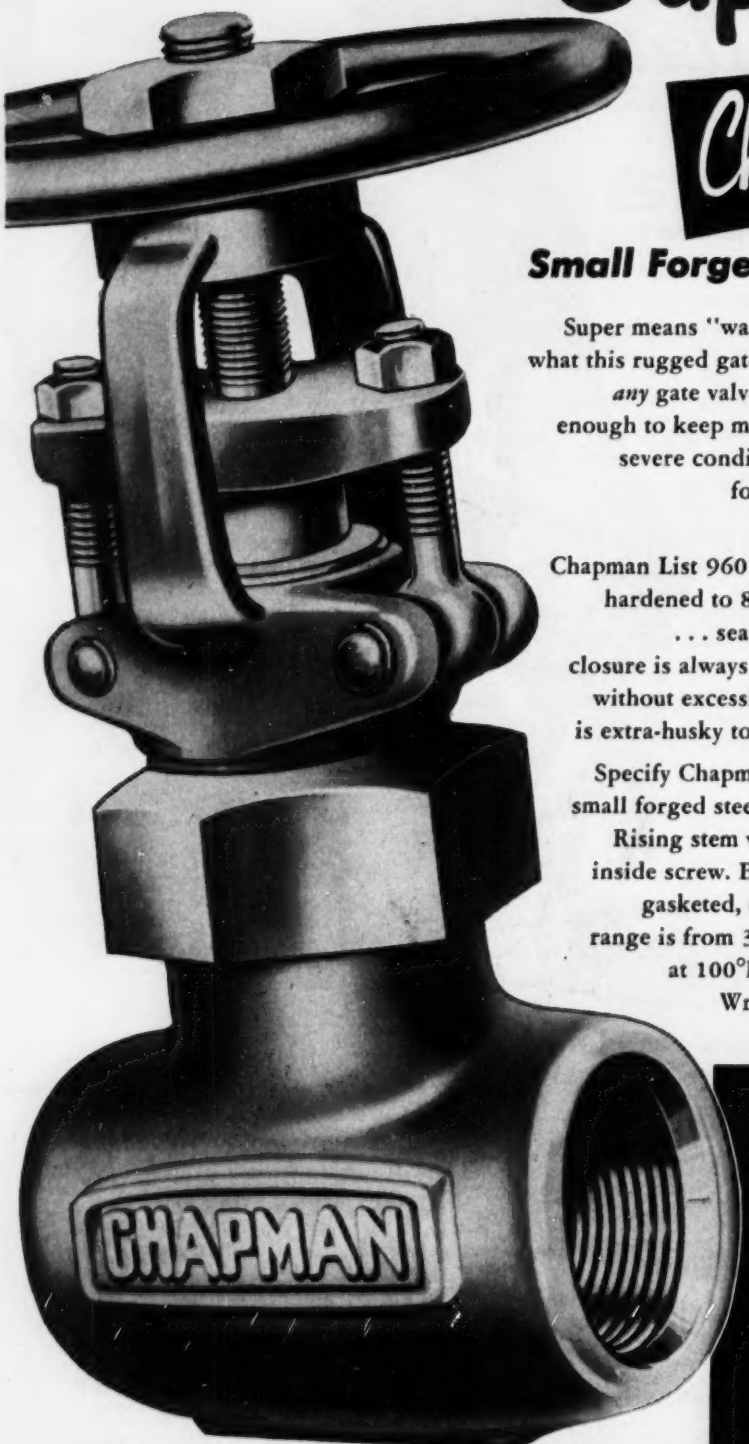
Chapman List 960

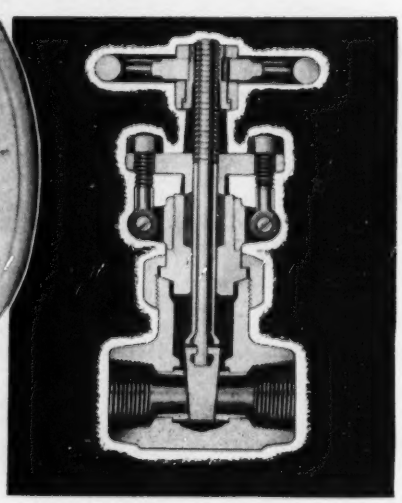
Small Forged Steel Gate Valve

Super means "way beyond the ordinary" and that's just what this rugged gate valve is . . . it's tough enough to lick *any* gate valve problem in its range . . . dependable enough to keep maintenance costs down under the most severe conditions. That's why List 960 is specified for more different applications than any other valve of its kind.

Chapman List 960 is tough because . . . wedge faces are hardened to 800 Brinell, so they won't seize or gall . . . seat rings are hardened stainless steel, so closure is always tight and operation is always smooth, without excessive wear . . . stem-and-gate connection is extra-husky to stand up under even unusual stresses.

Specify Chapman List 960 for every use you have for small forged steel gate valves. In sizes from ¼" to 2". Rising stem with yoke (shown) or rising stem with inside screw. Bonnet joint is either metal to metal or gasketed, depending upon application. Pressure range is from 380 pounds at 1000°F to 2000 pounds at 100°F. For higher ratings, specify List 990. Write today for your copy of Catalog 10.

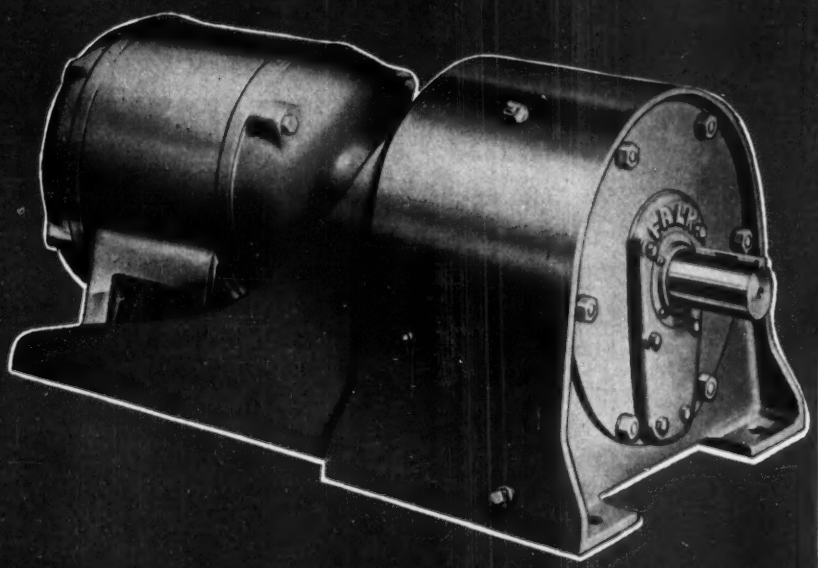




The CHAPMAN Valve Manufacturing Co.
INDIAN ORCHARD, MASSACHUSETTS

Choose the All-Motor type,

ALL-STEEL **FALK Motoreducer**



...with complete foot-mounted motor of ANY make ANY type ANY speed

Its exclusive, superior features mean LONG-RANGE ECONOMY!

You get more for your money in a FALK all-steel, All-Motor type Motoreducer. Here is the *only* compact motorized reducer with a separate foot-mounted, resilient Steelflex coupling-connected, standard motor without modifications! It accommodates *any* make, type, or speed of motor within the AGMA rating of the unit. Ratio can be changed within torque capacity of unit without modifying motor.

The simplified construction of the FALK All-Motor type Motoreducer means real long-range economy. Motors or reducer units can be quickly and easily interchanged from one line or plant location to another. Fully standard replacement motors from manufacturers' field stocks are always available without costly delivery delays or special motor or shaft modifications.

When you choose a FALK All-Motor type Motoreducer, you get the utmost in design, versatility of performance, and utility—plus the greatest possible dollar-for-dollar value throughout its traditionally long life... Available in any standard ratio from factory and distributor stocks throughout the country. Write for Bulletin 3104.

FALK ...a good name in industry

THE FALK CORPORATION 3001 W. Canal St. Milwaukee 8, Wis.

Every FALK motoreducer has these "IN-BUILT" FACTORS

1 **All-steel Housings.** Unbreakable, strong, rigid. Generous overhung load capacities provided by wide bearing spans, large shafts and bearings.

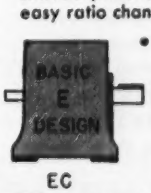
2 **Streamlined inside and outside.** Smooth, clean surfaces; machine welded construction conforms to NEMA motor frames.

3 **Sealed Housings.** Dual closures and one-way vents keep oil *in*, dust and moisture *out*. Units are splashproof, leakproof, dustproof.

4 **Positive Lubrication.** Large sump capacity ...oil-tight construction assures clean lubricant...direct dip of revolving elements provides positive lubrication at all speeds.

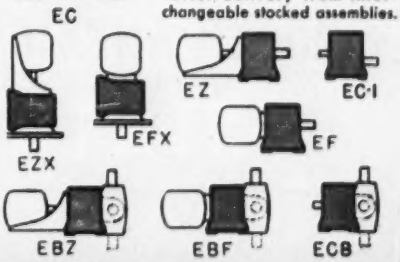
5 **Wide Speed Range.** Selective ratio combinations provide output speeds from 1.5 rpm to 1430 rpm with stock gears.

6 **Precision Gearing.** Heat-treated alloy steel, precision cut and shaved helical gearing throughout...quiet-operating crown shaved pinions...taper bored gears for easy ratio changes.



EC

The basic E design permits maximum use of standardized parts . . . closer control over materials, processing, inspection and assembly . . . resulting in faster delivery from interchangeable stocked assemblies.



WRITE FOR BULLETIN 3104

How to Ship Chemicals CLEAN, SAFE, SURE ..ALL THE WAY!

It's really simple. Go North American all the way. North American's specialized chemical tank cars transport your products with speed and safety anywhere there's a railroad main line, spur or siding. No contact with metal, no corrosive action, no chance for contamination, you specify the lining and we will obtain it for you . . . your chemicals arrive as clean and pure as you produced them. Specify North American, for chemical bulk shipping at its best.

For Special Products Requiring Special Care

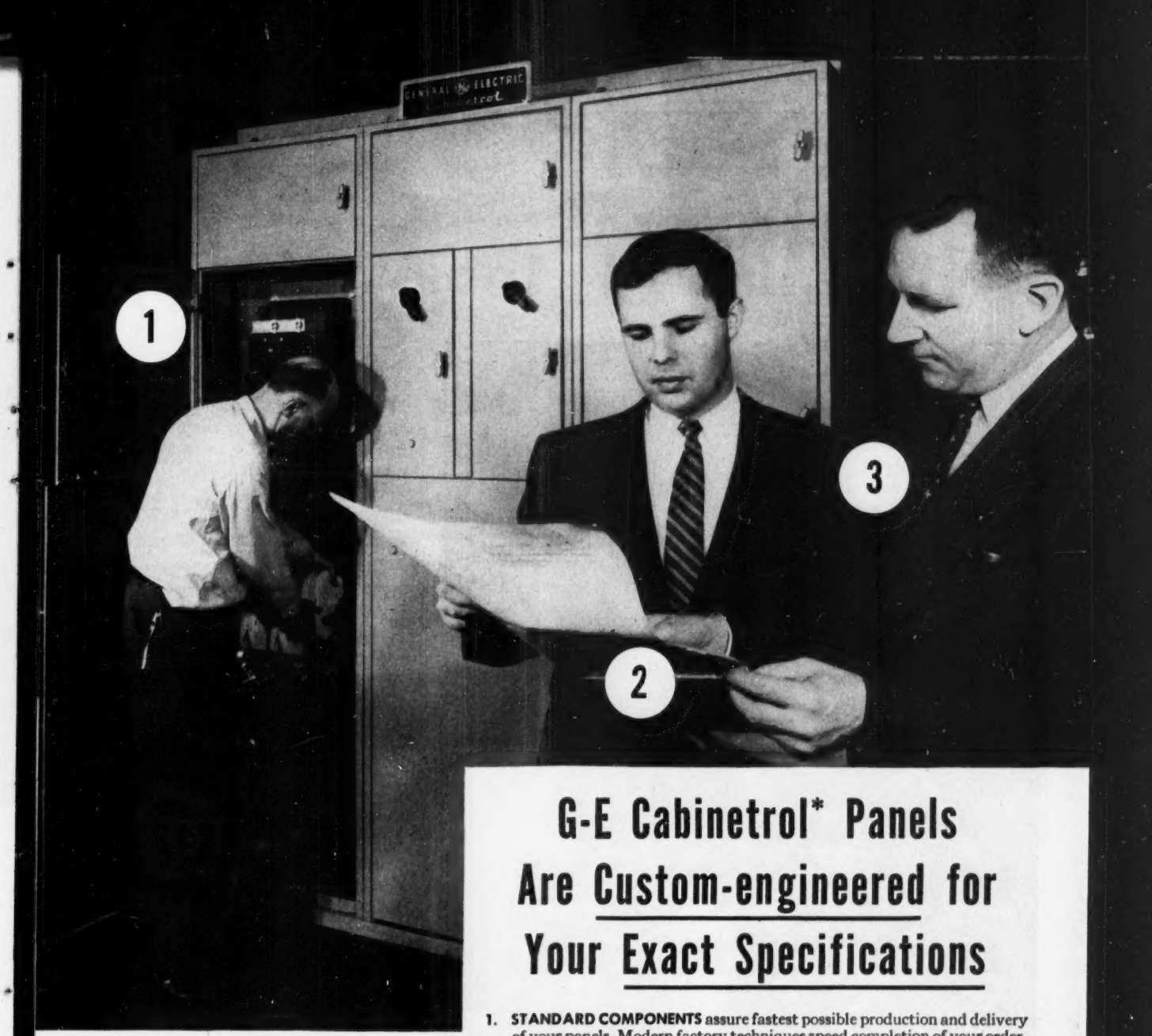
ROOM 1429 KIRBY BUILDING, DALLAS, TEXAS
739 PILLSBURY AVENUE, ST. PAUL 4, MINN.
SHELL BUILDING, ST. LOUIS 3, MO.
91 SOUTH MAIN STREET, FOND DU LAC, WIS.
681 MARKET STREET, SAN FRANCISCO 5, CALIF.
60 EAST 42ND STREET, NEW YORK 17, N. Y.
341 KENNEDY BUILDING, TULSA, OKLA.

NORTH AMERICAN CAR CORPORATION

NORTH WESTERN REFRIGERATOR LINE COMPANY

231 South LaSalle Street, Chicago 4, Illinois

A NATIONWIDE ORGANIZATION WITH BRANCH OFFICES IN IMPORTANT MARKET CENTERS



G-E Cabinetrol* Panels Are Custom-engineered for Your Exact Specifications

1. **STANDARD COMPONENTS** assure fastest possible production and delivery of your panels. Modern factory techniques speed completion of your order.
2. **YOUR REQUIREMENTS** are followed exactly. Thorough examination and testing assure "job-tailored" performance.
3. **EXPERIENCED G-E ENGINEERS**—working closely with you—design the unit to meet your application.

Cabinetrol panels are not costly, improvised modifications of some other type of control center. These panels form a **standard** low-voltage control system which handles all motor types up to 600 hp from a central location. You get the time-saving and money-saving advantages of standard components which are custom-assembled.

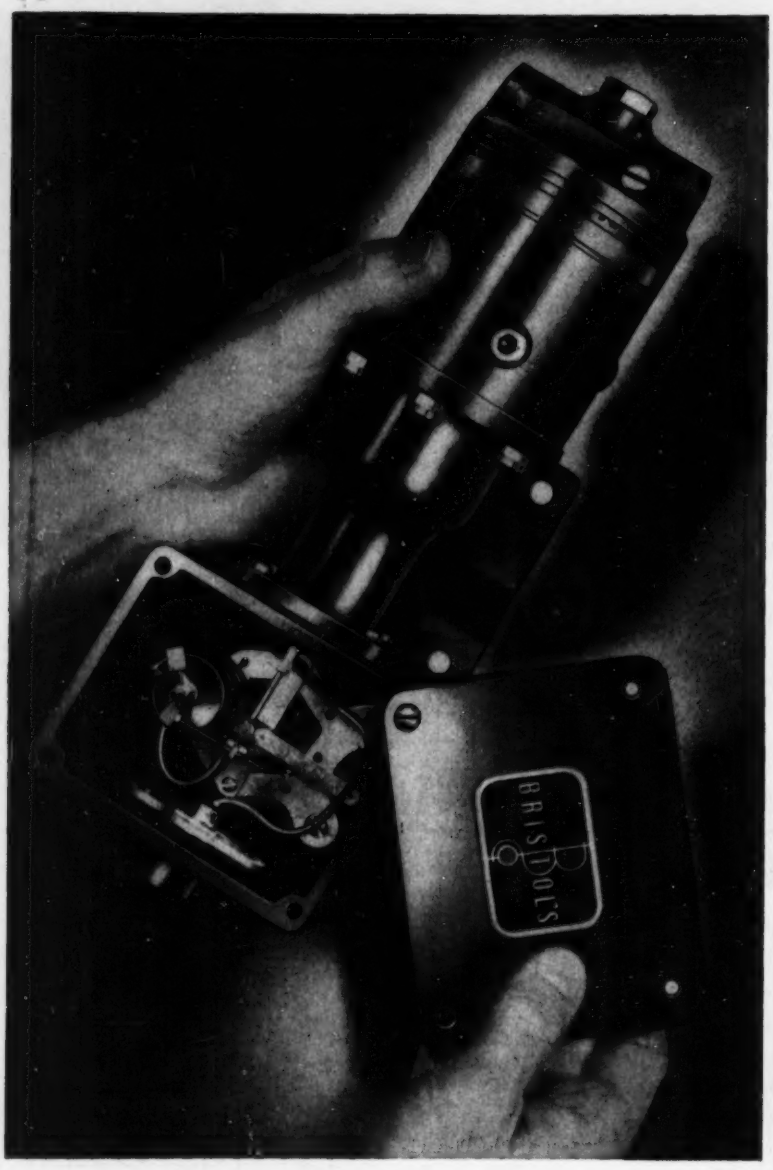
For complete information, contact your nearest G-E Apparatus Sales representative. Or write for the descriptive bulletin, GEA-3856. Section 780-4, General Electric Company, Schenectady 5, New York.

*Reg. trade-mark of General Electric Co.

GENERAL ELECTRIC

WHAT'S NEW AT BRISTOL...

SIMPLICITY? Look inside!



Remove the cover from the new Bristol Metagraphic pneumatic transmitter. You see at once the inherent simplicity of Bristol's world-famous measuring element.

These Bristol measuring elements have chalked up as much as 35 years' continuous service without attention.

The Metagraphic transmitter sets new standards of accuracy and reliability in measuring and transmitting readings of temperature, pressure, vacuum, differential pressure and liquid level. Here are some of its features:

NON-BLEED BOOSTER PILOT for low air consumption. In balanced position, air consumption is only 0.07 scfm.

HIGH-SPEED TRANSMISSION and superior control result from large air capacity of the pneumatic relay – 3.0 scfm.

INDICATING DIAL GAUGE to show output pressure can be screwed into front of transmitter. No piping or fittings are needed.

Get the whole story on the Metagraphic transmitters. Write for free bulletin A105 to The Bristol Company, 109 Bristol Road, Waterbury 20, Connecticut.

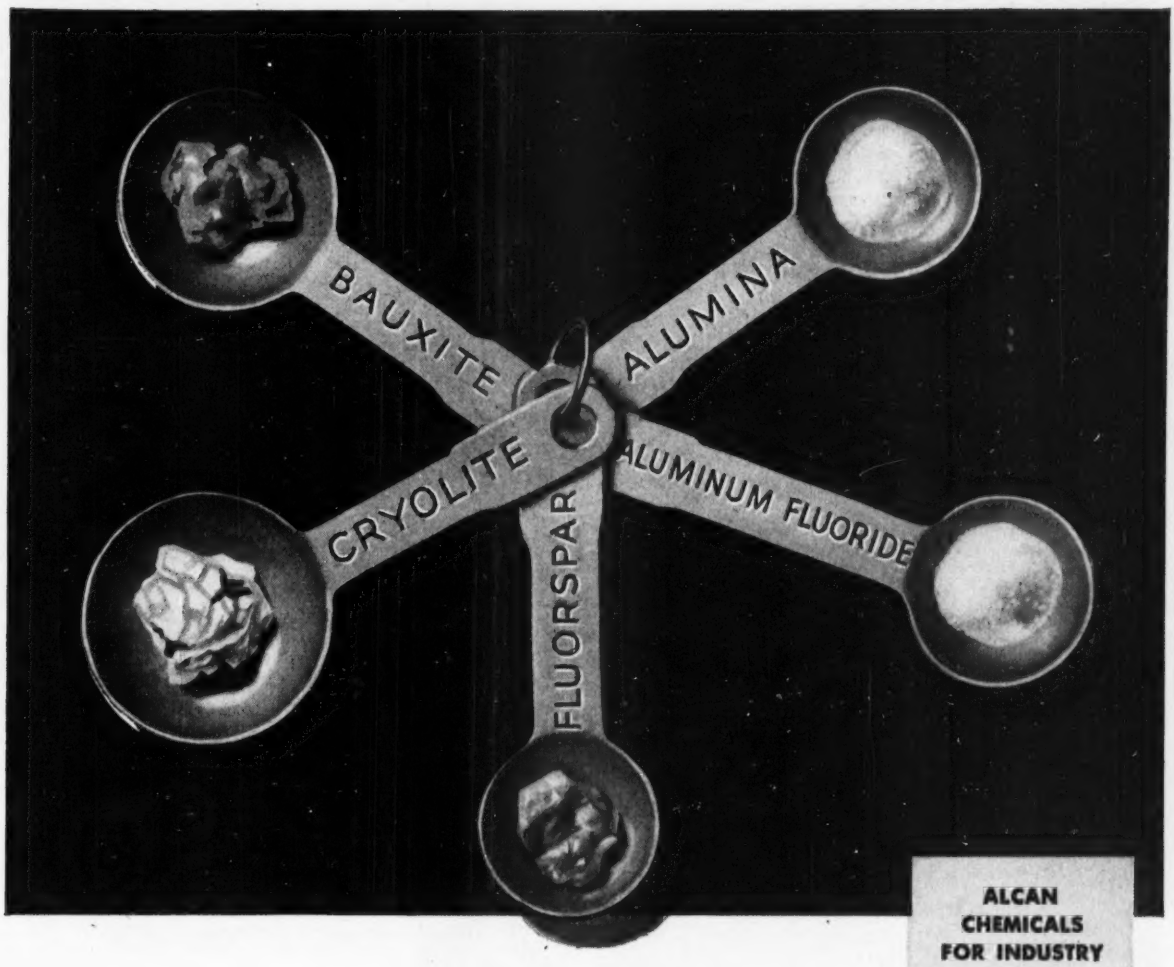
FRICTIONLESS METAGRAPHIC TRANSMITTER has only one pivot, no flexures. It's sensitive to extremely small changes in the measured quantity (as minute as 0.03% of range, including reversal). You can get the Metagraphic in a wide selection of ranges, with magnified ranges available and over-range protection standard.

4.24

BRISTOL

POINTS THE WAY IN HUMAN-ENGINEERED INSTRUMENTATION

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS



In the recipe

for an ingot of aluminum . . .

go many chemicals including those shown here. As one of North America's great producers of aluminum, Alcan (Aluminum Company of Canada, Ltd.) must be sure their chemicals are right. You may depend on Alcan chemicals for your use, too. Co-operating in their production are Alcan's sister companies. Each of these affiliates specializes in its own field of endeavor:

- **Laboratory research and the exploring and surveying of material resources throughout the free world;**
- **Mining and processing of raw materials in many different countries;**
- **Development of up-to-date shipping methods for the protection and speedy delivery of the products.**

One of Alcan's sister companies, Aluminium Limited Sales, Inc., distributes Alcan Chemicals in the United States. The office near you will be glad to help you with your special chemical requirements.

ALCAN CHEMICALS FOR INDUSTRY

Alumina, Activated
Alumina, Calcined
Alumina Hydrate
Aluminum Chloride, Anhydrous
Aluminum Fluoride
Aluminum Sulphate
Bauxite
Chlorine, Liquid
Cryolite, Artificial
Fluorspar
Lime
Magnesia
Magnesium Chloride, Anhydrous
Sodium Fluoride
Sulphuric Acid

ALCAN Aluminum Chemicals

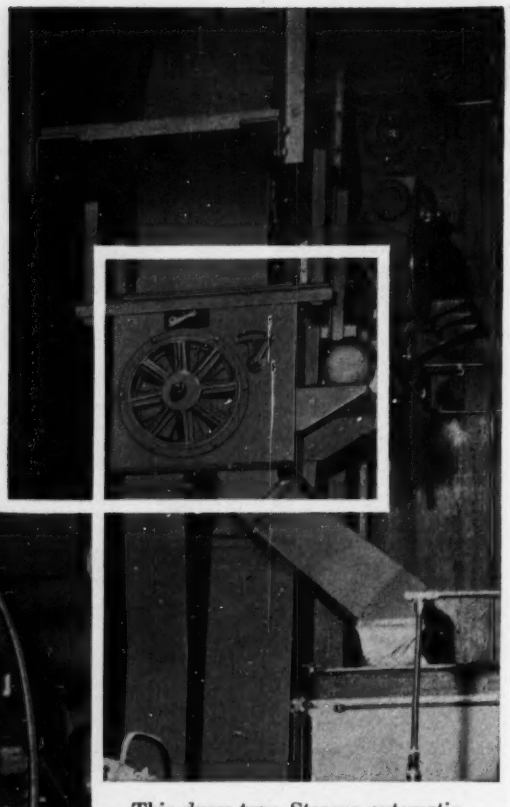
ALUMINIUM LIMITED SALES, INC.

One of the **ALUMINIUM LIMITED** group of Companies

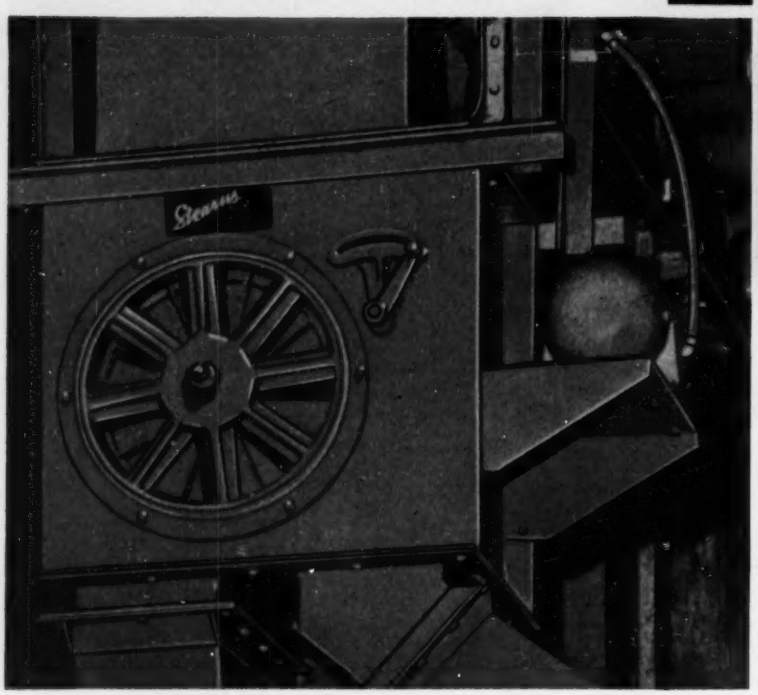
Offices or Agents in 40 cities
Cable: ALIMPORT

630 Fifth Avenue, New York 20
20 North Wacker Drive, Chicago 6
422 Terminal Tower, Cleveland 13
2842 West Grand Boulevard, Detroit 2
611 Wilshire Boulevard, Los Angeles 17

Here's non-stop protection from tramp iron



This drum-type Stearns automatic spout magnet is removing tramp iron in a new push-button feed plant in Goshen, Indiana.



Install a Stearns drum-type magnetic spout separator and forget about tramp iron hazards. This efficient Stearns unit removes destructive bolts, nails, tacks, etc. from your product — *continuously, automatically!*

Stearns magnetic specialists study every aspect of your installation, then design and build a magnetic separator that's *tailored exactly to your plant and product.*

Take a positive step to plant safety and product purification. Write today for Stearns bulletin 93-E.

Here's how it protects your product

Material in process can be fed into the separator at any angle, over a stainless steel cylinder surrounding a stationary electro or permanent magnet. As this material passes through the magnetic field, the contaminating tramp iron is held to the face of the cylinder and carried to a point beyond the magnet's pulling force and dropped into a discharge chute! The purified product falls by natural trajectory into a separate chute and continues through its production process.

No levers — no cleaning — no time-wasting interruptions. Deep, powerful magnetic field of a Stearns separator insures positive protection — even with large amounts of fast-flowing material.

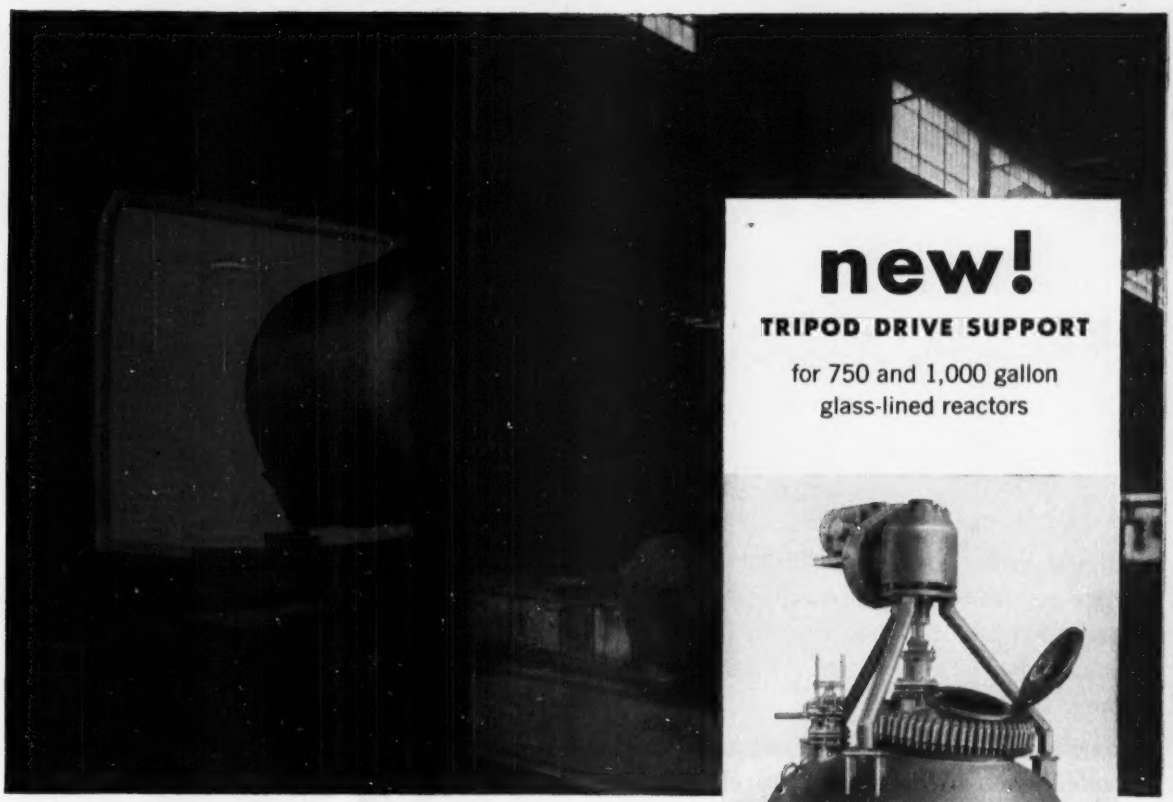
1079

MAGNETIC EQUIPMENT FOR ALL INDUSTRY

STEARNS MAGNETS

STEARNS MAGNETIC, INC.

629 S. 28th St., Milwaukee 46, Wis.



new!

TRIPOD DRIVE SUPPORT

for 750 and 1,000 gallon glass-lined reactors

Typical of the exclusives you secure with Glascote products is this true tripod drive support. It has excellent stability because of its heavy tubular construction. It simplifies piping layout, provides better accessibility to agitator stuffing box and maximum clearance of ports . . . a plus value obtainable only from Glascote.

Glascote

PRODUCTS, INC.

An A. O. Smith subsidiary

Where glass weds steel for corrosive service

We invite you to share in the advantages which are provided in glass-on-steel processing equipment obtainable under the Glascote name. As a producer of chemicals, petro-chemicals, pharmaceuticals, plastics or synthetics, you will appreciate the superior corrosion resistance and design of Glascote reactors, receivers, condensers, evaporators, storage tanks and transport tanks.

You will find our acid-resistant . . . or acid- and alkali-resistant . . . glass, fused to the appropriate steel backing, a dependable defense against corrosive attack. It withstands both thermal and impact shock. It assures extended life for the vessel and effectively protects materials in process from metallic contamination.

Look to Glascote for the corrosion-resistant processing equipment you need . . . in standard or custom designs.

Glascote

PRODUCTS, INC.

CLEVELAND 17, OHIO

A subsidiary of A. O. Smith Corporation

Sales offices or agents in Principal Cities
Export Sales: A. O. Smith Corporation, International Division, Milwaukee 1, Wisconsin

THERE'S NO MAGIC ABOUT IT

. . . NOR IS THERE ANY MAGIC in saving time on even the most complicated process construction job when it's in the hands of qualified men . . . Procon men.

Saving time is the logical result of a combination of factors . . . careful planning at the outset . . . engineering competence . . . broad experience that insures quick decisions, and right ones . . . proper coordination of all duties . . . a thorough knowledge and understanding of every operation involved . . . a willing acceptance of responsibilities . . . plus a sincere desire to make every hour productive to the fullest extent.

These are Procon's standards, and while the time saved will be of great value to you, it will cost you nothing extra . . . another important reason for entrusting your next process construction job to Procon.

PROCON *Incorporated*

PROCESS CONSTRUCTION

1111 MT. PROSPECT ROAD, DES PLAINES, ILLINOIS, U. S. A.

IN CANADA | PROCON (CANADA) LIMITED
40 ADVANCE ROAD
TORONTO 18, ONTARIO

IN ENGLAND | PROCON (GREAT BRITAIN) LIMITED
112 STRAND, LONDON, W. C. 2

PROCON

TRI 55 CLAD THE LEADER IN MODERN MOTOR DESIGN

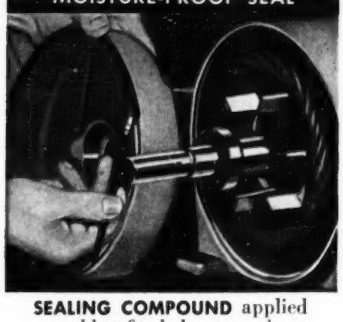
JET COOLING

A BLANKET OF AIR spreads over entire surface, cooling and cleaning the new Tri/Clad '55'.

CORROSION-RESISTANT FAN

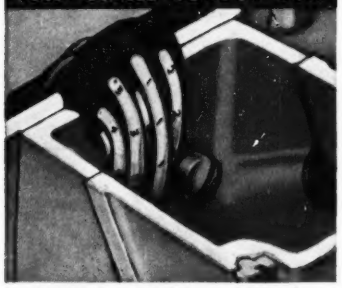
TEXTOLITE* FAN resists acids, alkalis . . . is one of chemistry's vital contributions to the motor.

MOISTURE-PROOF SEAL



SEALING COMPOUND applied on rabbet fits helps to seal out corrosives, moisture and dirt.

FULLY SEALED CONDUIT BOX



RUBBER GASKET waterproofs lead entry to stator of motor. Conduit box is also gasketed.

Now, the new chemical motor . . .

G-E TRI 55 CLAD enclosed motor resists corrosion and moisture!

REG. U.S. PAT. OFF.

General Electric's all-new Tri/Clad '55' enclosed motor meets the tough requirements of the chemical industry. Truly a chemical motor, the Tri/Clad '55' takes advantage of the industry's latest materials including silicone, polyester film, Textolite* and neoprene.

Because it's better protected, this standard motor gives you longer motor life in tough jobs. Frame and end shields are rust-resistant cast iron. Carefully machined rabbet fits are tightly sealed. Rubber gasket protects lead entry to stator.

New insulation materials also add life to this motor. A silicone Dri-film* coating on the stator sheds water—reduces insulation failure due to moisture. New polyester-film for slot and phase insulation is eight times stronger.

General Electric Tri/Clad '55' motors are available now in many ratings. The entire line, 1 to 30 hp a-c motors, available soon. For full details contact your nearby G-E Apparatus Sales Office or G-E Motor Supplier today. For bulletins on the complete line, write General Electric Company, Section 643-8, Schenectady 5, New York.

*Reg. trade-mark of General Electric Co.

Progress is our most important product

GENERAL ELECTRIC

Make sure the screw conveyors you buy pass this quality test!

If they don't . . . investigate LINK-BELT's sound engineering and quality manufacture . . . your assurance of top performance

1. Is flighting accurately formed?

Link-Belt's specialized machinery assures accurate forming, producing uniformity of flighting curvature.

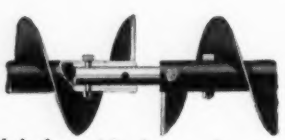
2. Are diameters uniform?

Only specially selected steels are used to meet Link-Belt's rigid specifications.

3. Will the hangers match your exact needs?

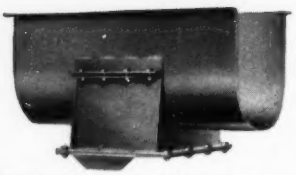
Hangers are available in gray iron or steel frames in a range of styles and with various bearing materials.

4. Will installation be easy?



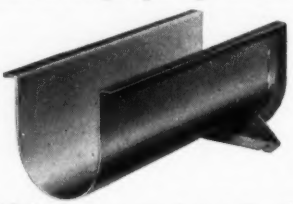
Straightness is checked before shipping, and extra care is taken in handling and loading. Jig-drilled coupling bolt holes facilitate assembly.

5. Can gates be installed on the job?



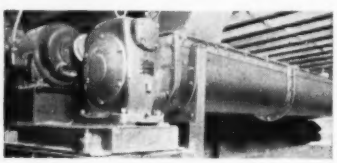
Gates are available for bolting or welding in place right on the job for ease of trough opening location.

6. Are troughs fabricated to your specifications?



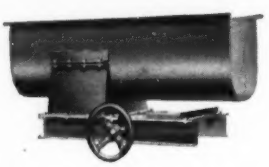
Link-Belt's accurate fabrication assures better fit of all components. Choice of metals to fit your need.

7. Is the drive fully integrated?



Only Link-Belt builds a complete line of gear and chain drives, couplings, bearings, shafting.

8. How wide a choice of spouts and gates do you have?



Discharge spouts and gates can be fixed or detachable. Hand or rack-and-pinion, flat or curved slide gates.

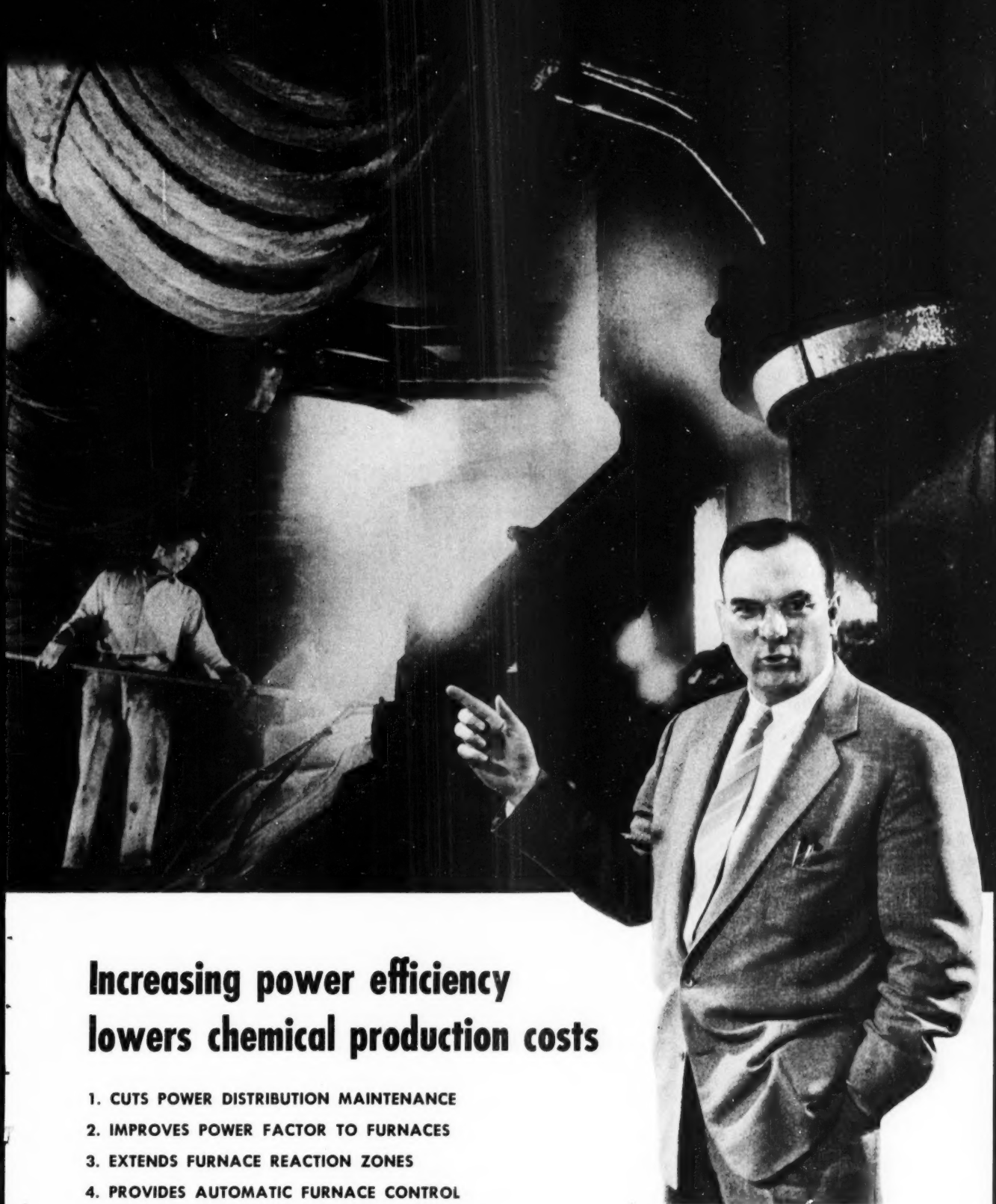
9. Is full ordering information readily available?

Link-Belt's 92-page Screw Conveyor Book 2289 contains complete ordering data. Ask your Link-Belt representative or distributor for your copy today.

LINK-BELT

13.820 **SCREW CONVEYORS**

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office: New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World.



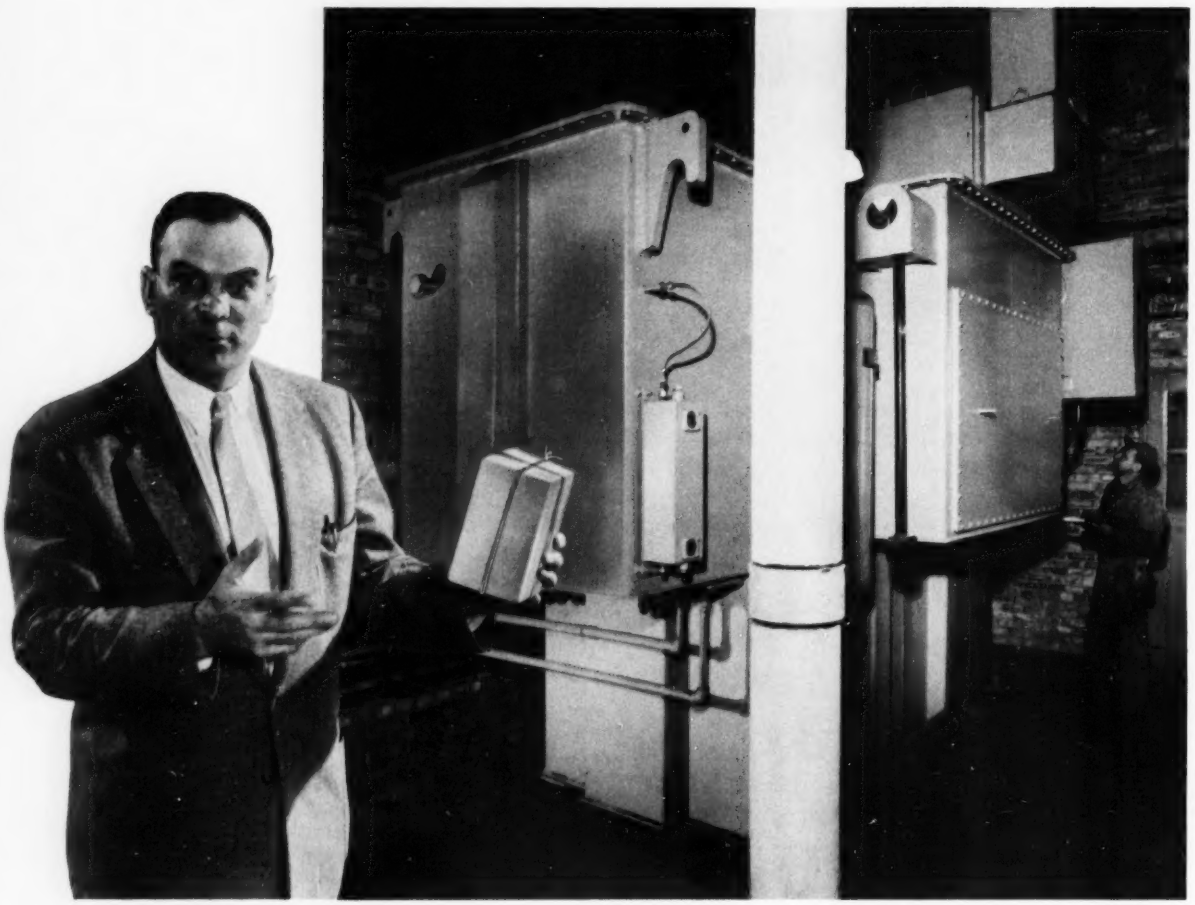
Increasing power efficiency lowers chemical production costs

1. CUTS POWER DISTRIBUTION MAINTENANCE
2. IMPROVES POWER FACTOR TO FURNACES
3. EXTENDS FURNACE REACTION ZONES
4. PROVIDES AUTOMATIC FURNACE CONTROL
5. INCREASES POWER RECTIFICATION RELIABILITY
6. REDUCES HAZARDS OF CORROSION
7. REDUCES TOTAL POWER CONSUMPTION

On the next 7 pages, Ira Coen, Manager, Chemical Industry Sales, Westinghouse Electric Corp., shows you how the right combination of electrical equipment cuts production costs.

YOU CAN BE **SURE**...IF IT'S Westinghouse

Packaged installation resulted in improved power efficiency gain at this plant



Shell-type Westinghouse Furnace Transformer serving phosphorus reduction furnace. Provided high power factor, cut total power costs.

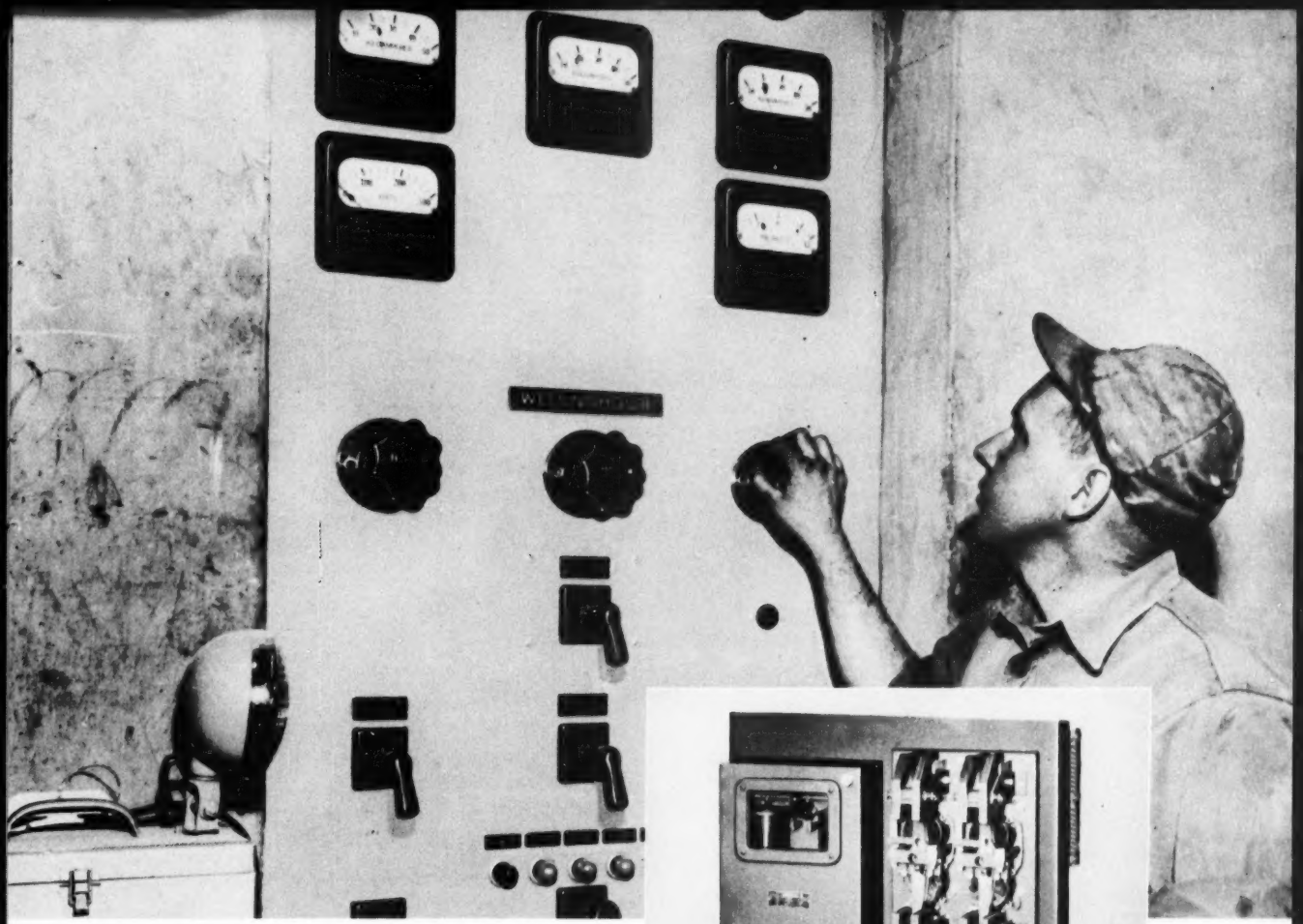
Shell transformer can be installed close to load to improve power factor

Basic producers — large, medium, or small — can bring power to unit processes more economically and use it more efficiently, for a net increase in production and reduction in power cost.

One company, in cooperation with Westinghouse Engineers, planned an electrical package from power supply to furnace that did just that.

The first important step was to bring furnace transformers as close to utilization points as possible, so that secondary leads were short. Resulting high power factor cut energy costs considerably. The furnace is operated at high voltage close to the load, providing electrical efficiency approximately 10% higher than usual.

The Westinghouse Shell-type Transformer is basically a far better performer, electrically and mechanically, for applications such as this where electrical equipment must stand the terrific punishment of cyclic loading and high current surges. Westinghouse Shell Transformers are more compact, provide better cooling, are gas and moisture tight. Maintenance is lower.



Operator's panel for arc furnace—current settings are made here.

Type AU Regulator assembly for one electrode; each is comprised of AU Regulator electrode element and reversing contactor.

Westinghouse Type AU Balanced Beam Regulator provides automatic operation and accurate control of energy to furnace

The second major step in this installation was the choice of the Westinghouse AU Regulator as the furnace control system. This regulator balances arc voltage and current to maintain the desired power input set by the operator, consistently and precisely.

If furnace conditions change, position of electrodes within the charge is automatically changed to maintain the current pre-set by the furnace operator. The Type AU Balanced Beam Regulator was the first arc furnace control which measured both arc current and voltage in positioning electrodes and is the only balanced beam type now available.

The Type AU Regulator acts fast to correct current unbalance but doesn't overshoot or hunt. The sensitivity can be adjusted to suit particular furnace conditions. Properly applied and adjusted, the Type AU regulator will maintain electrode position to insure maximum continuous protection from chemical arc furnaces. It is particularly adaptable to use with automatic power regulating systems.

Westinghouse Type AU Balanced Beam Regulator is recommended as the most suitable and economical for most chemical arc furnace applications. For the few applications where a rotating regulator is desirable, the Westinghouse Rototrol® is available.

YOU CAN BE SURE...IF IT'S Westinghouse

One man and dependable Westinghouse Ignitron Rectifiers run this chlorine line

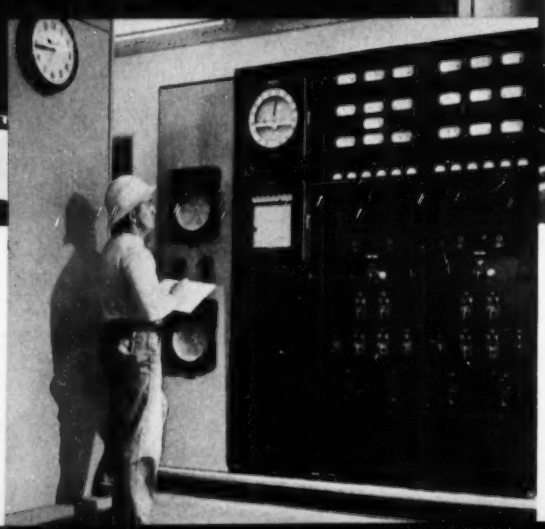
As this basic chemical producer has found, Westinghouse Ignitron Rectifiers bring a new standard of performance—high power conversion efficiency and low cost to electrolytic processes using power in the 250-3000 voltage range. The chlorine gas operation at this plant is comprised of 180 cells, connected in series, at 650 volts, and is served by a bank of 48 rectifier units.

The Ignitron Rectifier, developed by Westinghouse, introduces a basically new principle in the utilization of rectifying properties of the mercury vapor arc. At higher voltages, it is undisputably more efficient than motor-generator sets or rotary converters. Production cost savings are proportionally greater as voltages increase and, of course, as ratio of electrical energy per ton of finished product increases.

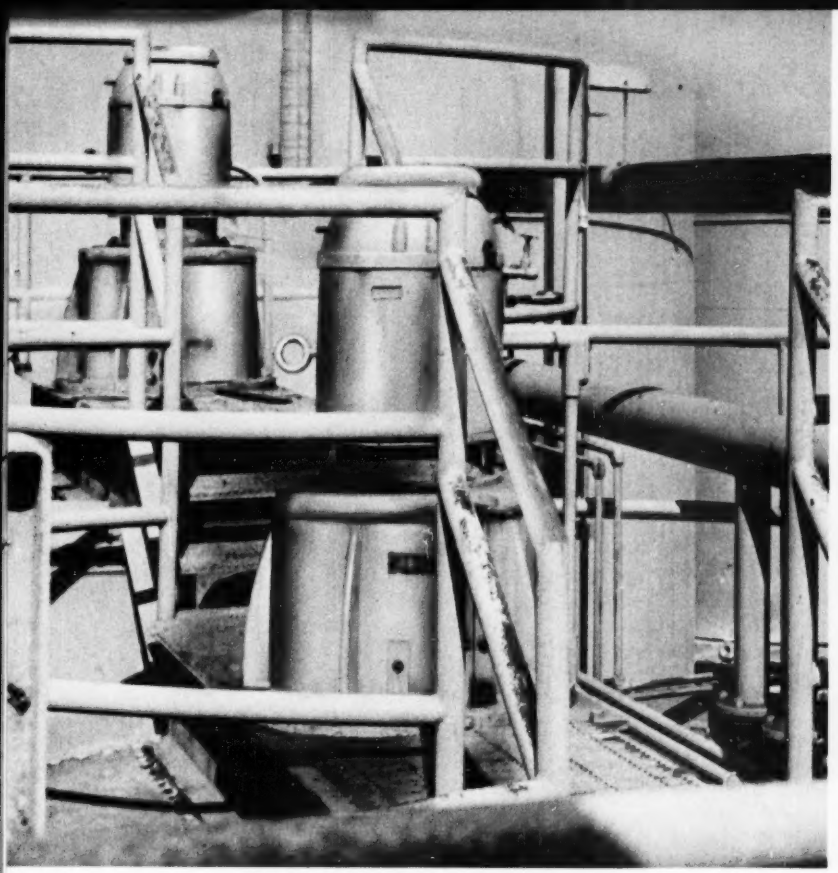
Operating headaches are eliminated, too—Ignitrons can be set up easily for automatic unattended operation. Availability of 99% or better in Ignitron installations often eliminates the need for stand-by equipment. Complete absence of moving parts drastically cuts maintenance. Ignitrons are inherently easier to protect against corrosion than any comparable rectifying equipment.

Westinghouse Ignitron Rectifiers offer you an unequaled opportunity for continuous throughput at rock-bottom cost.

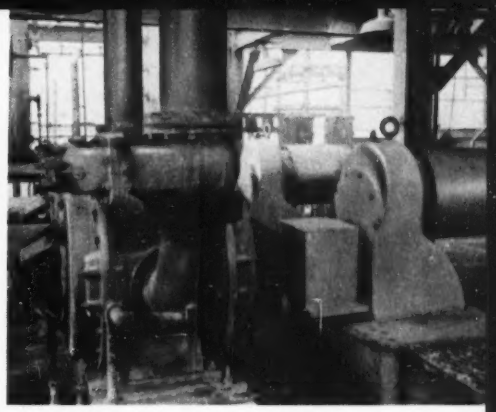
Bank of 48 Westinghouse Ignitron Rectifiers serving a chlorine production line.



Master chlorine rectifier control panel.



Life-Line Gearmotors, serving salt removal tanks, give automatic processing a boost with dependable, round-the-clock operation.



Life-Lines driving water recirculating pumps.

Westinghouse Control Center banks motor controls away from exposed production areas.

Gearmotors give vital 24-hour reliability driving pumps on salt removal tanks

Dependable, continuous circulation of tremendous amounts of water is critical in this plant. For the job, Westinghouse Gearmotors were chosen.

Both gear unit and motor in these compact units incorporate features that assure continuous service with a minimum of maintenance required. Accurately hobbed, specially treated gear teeth absorb heavy operating shocks and prevent damaging vibrations. Westinghouse Gearmotors have positive shaft sealing to prevent leakage of oil and entrance of foreign matter.

The Life-Line® Motor, an integral part of the gearmotor, is pre-lubricated—new 4-way seal bearings provide a continuous supply of motor grease without leakage and, above all, keep dust and dirt out.

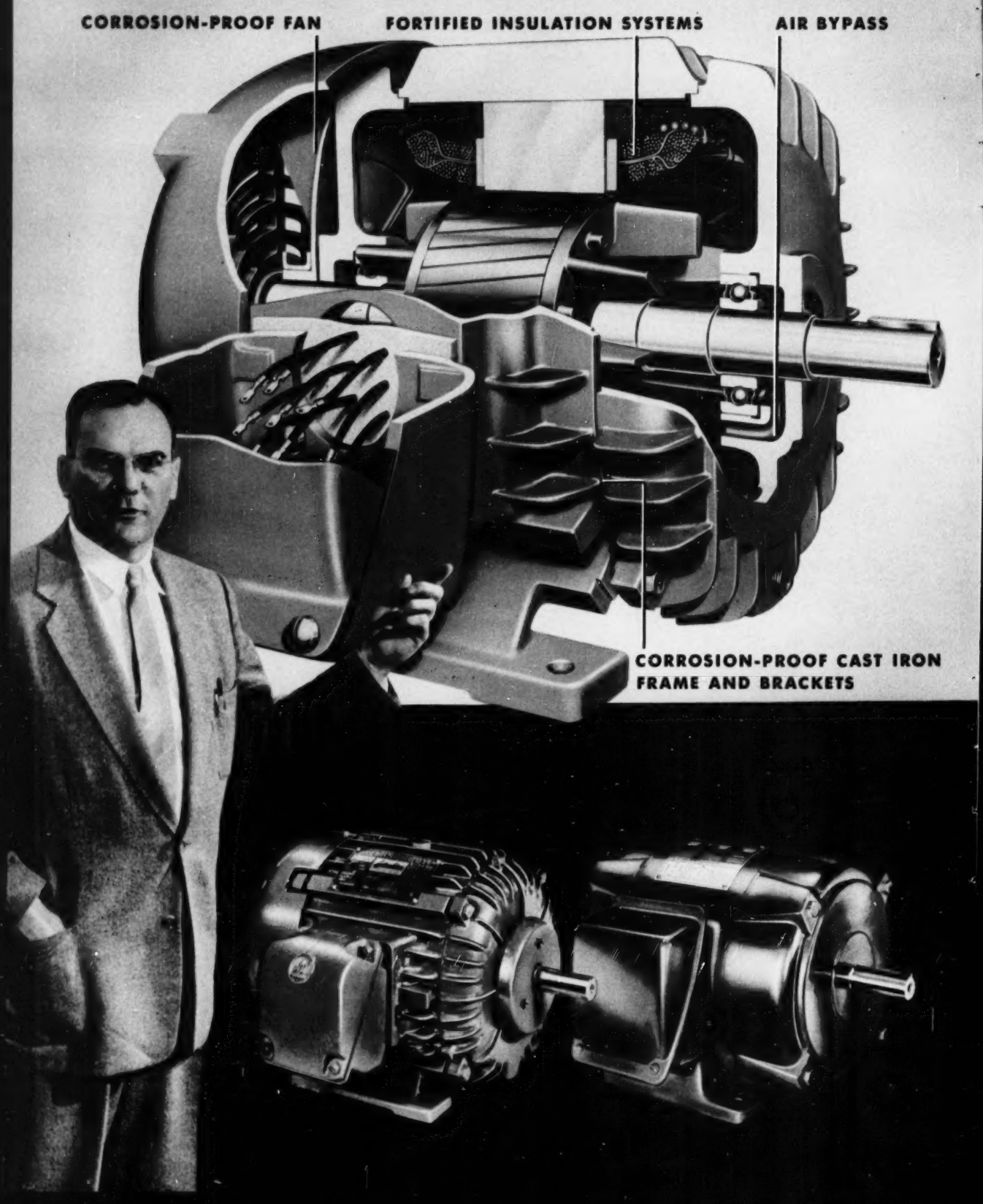
Westinghouse Control Centers locate control conveniently for emergencies, away from danger areas

For power or light, Westinghouse Control Centers offer the modern way to group motor starters in centralized, planned-away-from-production areas. They are particularly suitable in plants where atmospheres are heavily laden with dust or chemical gases. Maintenance people can get at them quickly and easily.

Individual control cubicles can be removed or replaced in a few minutes. Each unit is safely insulated from its neighbors.

YOU CAN BE **SURE**...IF IT'S **Westinghouse**

New Life-Line A motor in CAST IRON,



and matching control for corrosion resistance, more production

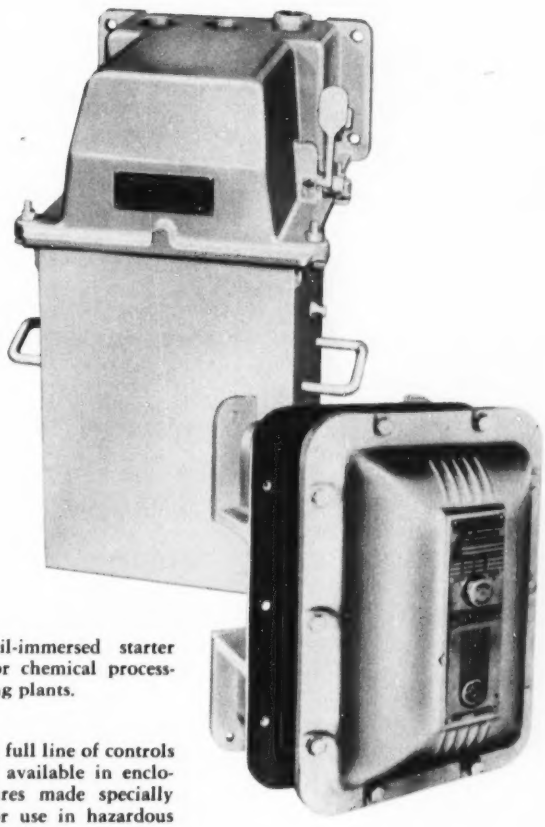
Setting big, new standards of performance is the new Westinghouse Life-Line "A" *better-protected* Motor. Here is a power package that is physically smaller, mechanically stronger and electrically longer lasting than *any* conventional motor.

Two basic models for all chemical plant applications—the dripproof for outdoor or other similar applications, and the totally-enclosed fan-cooled for corrosive applications—will assure you the same field-proved electrical performance Life-Lines have always given, but now in *CAST IRON* to withstand ravages of corrosive atmospheres. For 7-day week production, you now get:

1. Better protection for the lubrication system—new 4-way seal bearings, with double seals on each side of the bearing, effectively stop contamination. You still get the proved principle of prelubrication which prevents overgreasing or wrong grease—plus extra protection.
2. New fortified insulation: Mylar*, a slot insulation with greater dielectric and mechanical strength; Bondar, a wire insulation with more heat resistance; Bondite, a stator insulation with greater strength to withstand destructive elements.
3. New armorized enclosure, in *CAST IRON*, gives you even better protection against corrosion from chemicals, liquids or dirt, as well as protection against physical impact, and can be located anywhere and in any position.

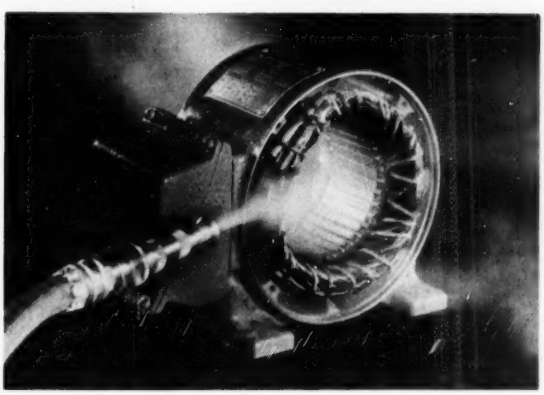
Rating for rating, horsepower for horsepower, the new Life-Line "A" Motor is the finest long-distance performer you can buy.

*DuPont Registered Trade-Mark



Oil-immersed starter for chemical processing plants.

A full line of controls is available in enclosures made specially for use in hazardous locations.



Life-Line's fortified insulation system provides higher thermal stability; resists moisture, oils, chemicals.

Here's a dust storm no motor will ever have to go through. Life-Line 4-way seal bearings stand up in any atmosphere.

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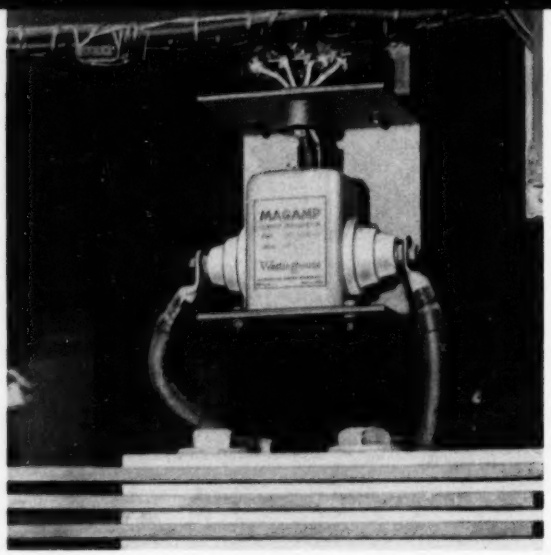
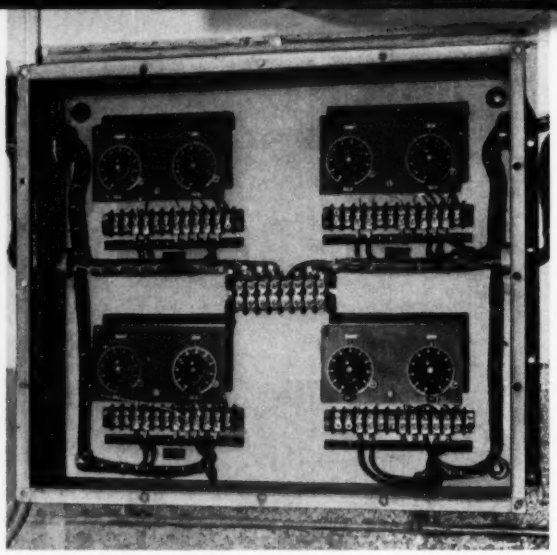


Westinghouse Magamp, transductor type, measuring amperage on a chlorine line.



Control panel serving Magamp unit.

Compact Magamp provides dependable check on d-c amperage consumed by Ignitron Rectifiers

A basic new regulating system, illustrated here on the chlorine line, is not only simpler and more compact than mechanical or rotating types, but is highly versatile as well. In this application, Westinghouse Magamp is used to totalize d-c amperage used in the banks of Ignitron Rectifiers.

Whether utilized for control of tension, voltage, current or speed, Magamp acts swiftly, accurately. Disturbances are instantly eliminated. Despite its small size and quick judgment, Magamp is ruggedly built, insensitive to normal shock and vibration. It has no moving parts — commutators, brushes, bearings — to wear, no tubes to burn out. It is a static device, and as such requires virtually no maintenance. Original resistor settings, made when the unit is installed, are permanent. Magamp is at your service and ready to go at the flip of a switch — no warm-up time needed.

For a low-cost production tool with high reliability in continuous operation processes, specify Westinghouse Magamp.

Westinghouse engineering can help you save power with the right combination of equipment

The most efficient, productive way to apply electrical equipment to arc furnaces or chemical processing lines is in an integrated system. Westinghouse builds all the necessary equipment, designed to work together. Why not put Westinghouse experience to work for you? Call us in early in the planning stage.

Inspection and repair needs are answered promptly by Westinghouse maintenance

Another important link in economical power supply can be the nationally recognized Westinghouse Maintenance and Repair Service, operated on the local level for fast — even emergency — service. To keep your plant producing, Westinghouse offers: equipment repair or reconditioning in 38 plants; inspection and on-the-spot repairs for equipment that cannot be moved easily through 56 field service offices; fast delivery of genuine Westinghouse Renewal Parts from stock in 31 locations.

MP-3028

For product literature, check the coupon below, and mail to Westinghouse Electric Corporation, 3 Gateway Center, P. O. Box 868, Pittsburgh 30, Pa.

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- ☐ Life-Line Gearmotors B-5645
- ☐ Speed Reducers B-5646
- ☐ The New Westinghouse Control Center B-4213
- ☐ The New Life-Line "A" Cast-Iron Motor B-6154
- ☐ Motors & Controls in the Chemical-Processing Industries B-4792
- ☐ Power for Electrolytic Processes B-5466
- ☐ Preventive Maintenance B-5477
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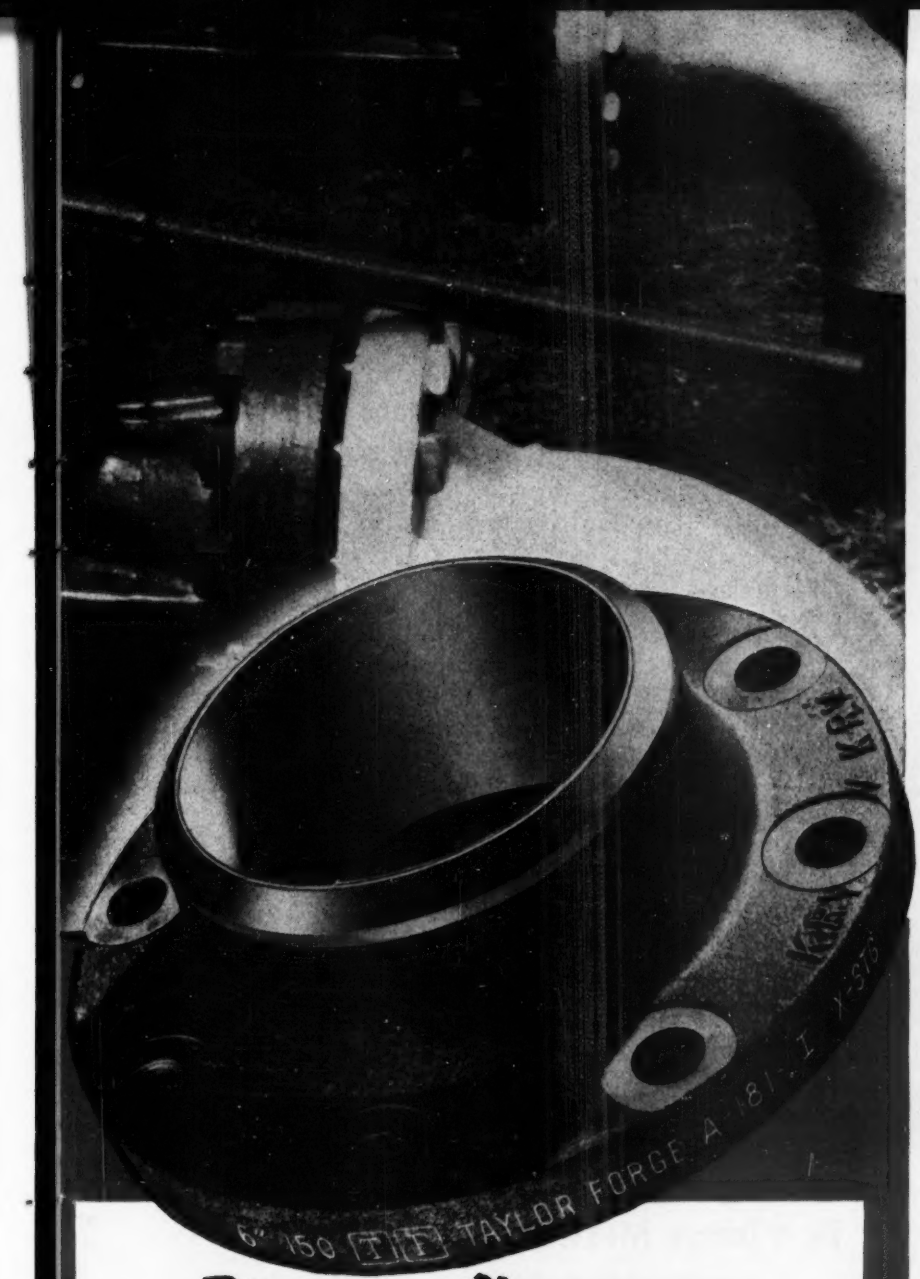

First in flanges—

No organization has been so closely identified with the development of forged steel flanges as Taylor Forge. No organization or individual has had so much to do with the study of design, strength, bolting practices, and the establishing of flange standards.

Taylor Forge started first and has remained first . . . in scope of flange types, sizes, weights, and materials . . . in volume produced.

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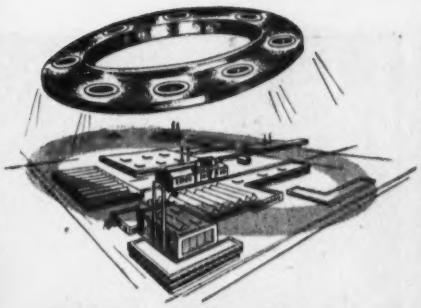

A flange with a future—

Even though no one knew it at the time, the year 1905 was a significant year for Taylor Forge.

It was the year that Taylor Forge began the making of forged steel flanges.

The beginning was modest enough. Taylor Forge simply started out to make flanges for Taylor Spiral Pipe because the only flanges then available — cast iron flanges—had proved unsatisfactory. But it was soon apparent that the men at Taylor Forge had built better than they knew. In just a few years, the new and stronger Taylor Forge Flanges were in demand everywhere—not just for Taylor pipe, but for all types of pipe used by U. S. industry.

It was also apparent that the forging of flanges had taken Taylor Forge into the dawning field of designed piping. Pressures were beginning to climb. Knowledge of how to contain them was needed. By 1920, the late J. Hall Taylor and his associates began the intensive research that was to make Taylor Forge not only the world's largest manufacturer of forged steel flanges, but also the foremost contributor to flange design and standards.

In the mid-20's, big strides were made in flange development to meet the broadened needs of the growing petroleum industry. By 1927, as the reward of long, intensive research, the authoritative Taylor-Waters formula was published. This research work demonstrated the design advantages of the hub type flange and provided the means for producing flanges accurately proportioned for strength combined with economy.

Most of this research had been concerned with the American Standards—flange sizes through 24"—but in 1938 Taylor Forge published the first edition of its widely consulted "Modern Flange Design," based on methods proposed by E. O. Waters, D. B. Rossheim, D. B. Wesstrom and F. S. G. Williams, manager engineering standards, Taylor Forge (ASME Trans. Apr. 1937). It provided the first complete analyses of the effects of tapered hubs on flange strength and thus opened the way to predetermine design requirements of flanges of all types.

(An episode in the story of Taylor Forge leadership in designed piping)

Forty years of research made this book possible. It is available to those interested in flange design.

OIL-FREE COMPRESSORS

VACUUM PUMPS and BOOSTERS

The battery of equipment illustrated is a typically efficient Joy installation. There's nothing new about oil-free compressors of course. Joy pioneered in their development, and has built them for more than 35 years.

Right above: Five JOY WNO-112 Oil-Free Compressors for pressure-testing of food containers, oil-free ejection of metal stampings, paint spraying and general oil-free processing service.

Left foreground: Three JOY WGV-9 Vacuum Pumps handle the job of vacuum feeding of metal sheets.

Left background: These three JOY WGB-9's boost gas pressure for the burners in the soldering process.

W&D 1-4016

giving highly satisfactory service in a large Midwestern Can Factory

For dependable *oil-free* air, day in and day out—as you may need it for any chemical processing or other special operation, or on that exacting instrument control job—there's a JOY OIL-FREE Compressor to meet your particular requirements. Dual Cushion valves, surface-hardened wearing areas and replaceable wearing parts are some of the exclusive JOY design features, and there's a complete line from 163 to 8800 CFM at pressures up to 100 PSI. A complete line of standard Compressors, Vacuum Pumps and Booster Compressors, too—and a line of Oxygen Generators of exclusive design. ● Write for Bulletin A-92, or . . .

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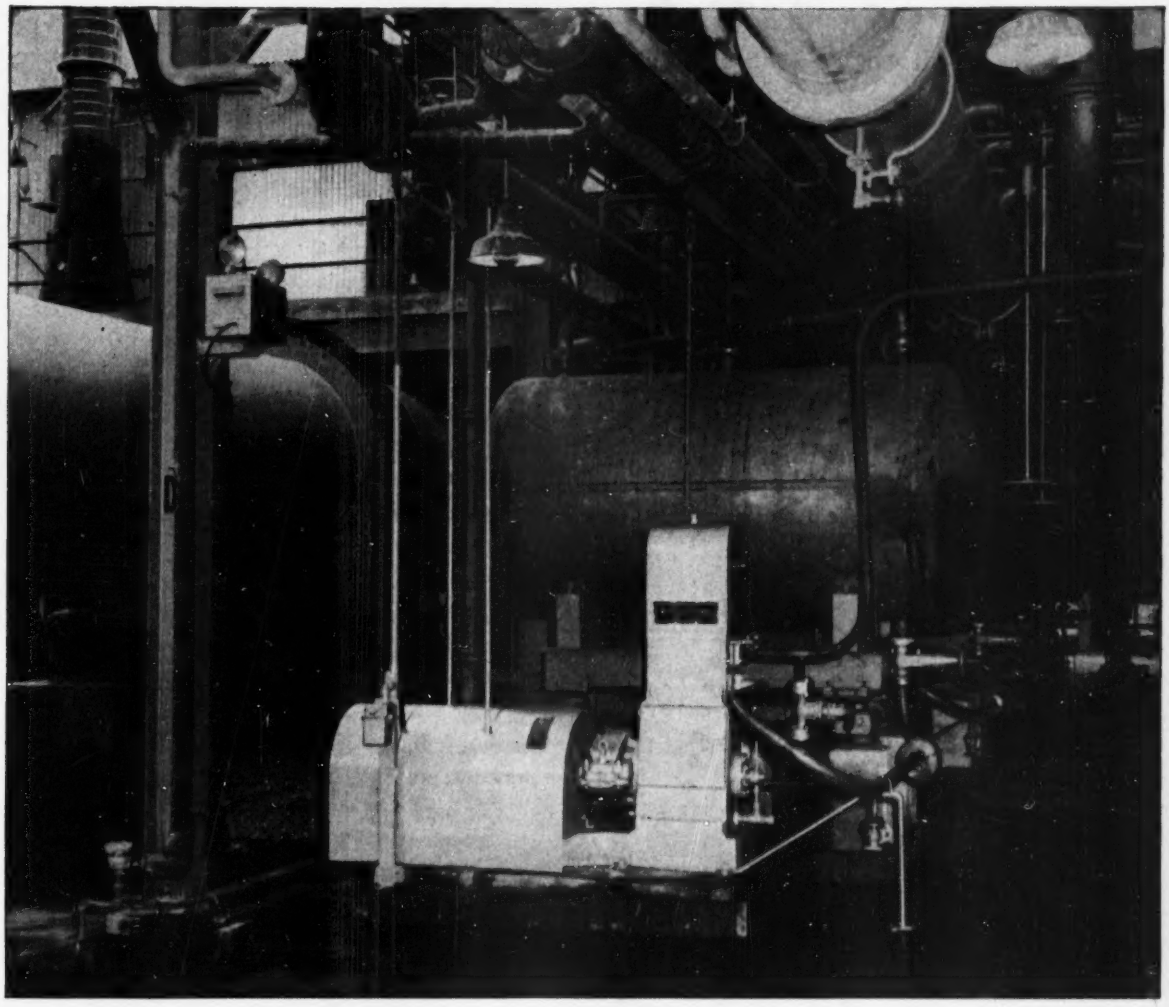

Another Chemical Pumping Job—handled by ALDRICH

This scene is the plant of a leading manufacturer of explosives, where the Aldrich Triplex Pump pictured in the foreground pumps nitric acid at the rate of 185 lbs. per minute against 400 psi maximum pressure.

It's one of many jobs Aldrich Pumps are called upon to do in the chemical industries. These versatile pumps are ideal wherever applications involve corrosion, abrasive materials, high viscosity or high pressure. In addition to nitric acid, among the many liquids handled by Aldrich Pumps are caustic solutions, fatty acids, acetic acid, aqua ammonia, anhydrous ammonia, as well as liquids encountered in the petroleum refining, petroleum chemical and other industries.

Several types of Aldrich Pumps are available to meet your specific needs. For automatically controlled delivery Aldrich-Groff "POWR-SAVR" Pumps can handle any free-flowing liquid at discharge pressures from 300 to 15,000 psi and are available in six sizes—from 2″ to 6″ stroke and from 5 to 125 bhp. (For information, write for Data Sheet 65.) For medium to high pressure service you may need one of the many Aldrich Constant Stroke Pumps—the Direct Flow Triplex or Multiplex Pump (Data Sheets 64, 64A, 64B).

Take advantage of our broad experience in building pumps for the chemical industry and let us make specific recommendations to meet *your* chemical needs. No matter what your problem, we welcome your inquiries or requests for literature.

The Aldrich Pump Company

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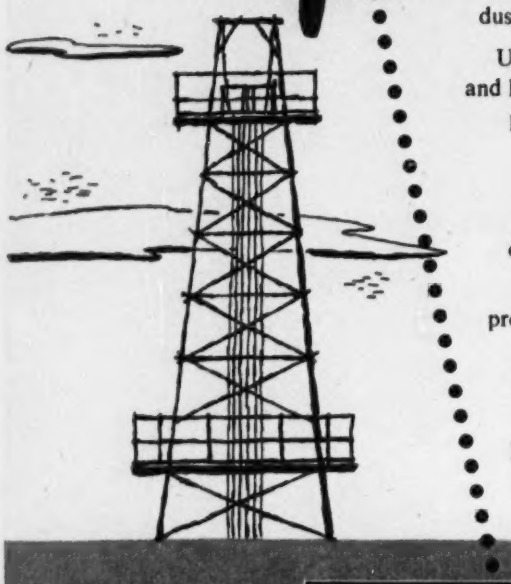
ALDRICH

NO MUD IN YOUR EYE HERE!



Here's how Dracco application engineering ended a serious dust nuisance for a Texas company manufacturing drilling muds.

Used in oil well drilling operations for bit lubrication and hole sealing, drilling muds are produced from specially processed clays. Bagging of these clays created severe dust concentrations at two plants, exposing personnel to unhealthy conditions.

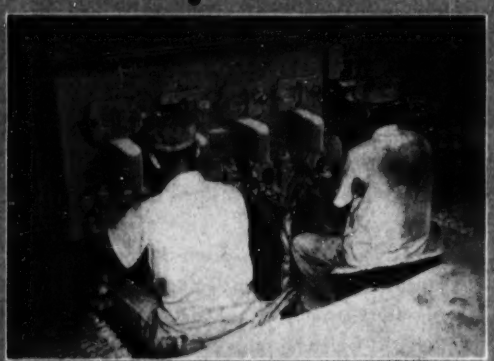
Dracco Multi-Bag Filters provided positive control of these dusts and brought immediate relief by eliminating all "dusty" mud.

Wherever Dracco Filters are put to work, they are constantly protecting plant efficiency . . . safeguarding workers' health . . . cutting housekeeping costs . . . reducing machine wear from abrasive dusts . . . or recovering valuable materials at collection efficiencies of 99½—100%.

If uncontrolled dust is muddying your profit picture, Dracco Filters can provide a proved method for solving your problem.

Men and machines (left photo) can now bag drilling mud materials at top efficiency in dust-free atmosphere.

Dracco Multi-Bag Filter (right photo) now controls nuisance dusts, assuring cleaner working conditions and higher production.



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Dracco 40-page Bulletin 800 presents complete technical information on "Industrial Dust Control and Recovery". Write for your copy today.

This detailed line drawing of the new, patented Veelos TD and TE v-belt makes it easy to see how this new v-belt is designed to do a better job . . . easier!

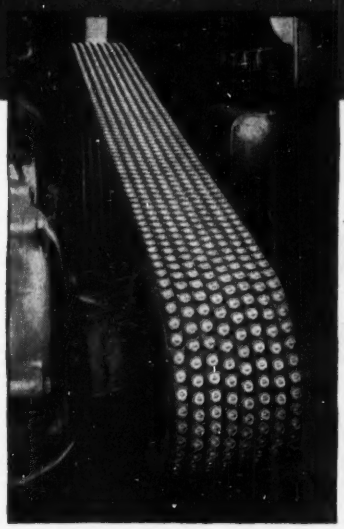
Link is beveled for extreme flexibility.

T-screw is made for strength and for easy coupling and uncoupling.

Cup-washer is shaped to resist belt wear.

Stud is anchored permanently in the link for added durability.

Individual link is designed for greater strength.



New VEELOS

TD and TE Adjustable V-belt

So easy to couple *it installs in minutes*

So strong and durable *it lasts for years*

The new Veelos TD and TE adjustable v-belt is the successful development of a specific v-belt designed for a specific service—D and E drives.

This new Veelos TD and TE v-belt has these basic advantages . . .

It simplifies installation. Links are quickly joined by easy-to-use cup-washers and T-screws to make up individual belts. It's the easiest v-belt to couple and uncouple ever developed. And you don't need to waste time removing outboard bearings.

It lasts longer—is more flexible. New high-tensile strength link combined with new stud, cup-washer, and T-screw gives added durability. New link construction provides maximum flexibility for cooler, wear-resistant running.

Get the complete story of this great new v-belt for D and E drives. Send coupon now for new 8-page illustrated catalog.

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602 Manbel St., Manheim, Pa.

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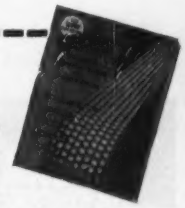

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This Bailey Armortube* Cable can save you time and money

With this new material especially designed for pneumatic connecting lines you can make better instrument and control installations in less time and at less cost. Here's why:

Simple — Standard ARMORTUBE* cable is stocked in three convenient sizes: bundles of four, eight, or twelve ¼ inch O.D. aluminum alloy or copper tubes. Other sizes are available on special order. It's a ready-made, fully protected piping material for transmitting pneumatic signals between measuring units, instruments, and control units.

Safe — The flexible metallic covering guards against every hazard, internal or external. Patented rope-like arrangement of tubes eliminates danger of collapse at sharp bends—and damage from external blows or vibration is minimized by protective outer covering.

Compact — All necessary lines can be snaked through tight quarters or around corners with a minimum of connections. No need for unsightly, bulky channels, racks or other special mountings.

Economical — Installation is fast. 100 foot coils and 500 foot reels permit long unbroken runs. Colored tracer simplifies connections at terminals. Slightly higher first cost is quickly amortized by savings in materials, and installation time. For further information and specifications ask for Bulletin and Price List G91-9.

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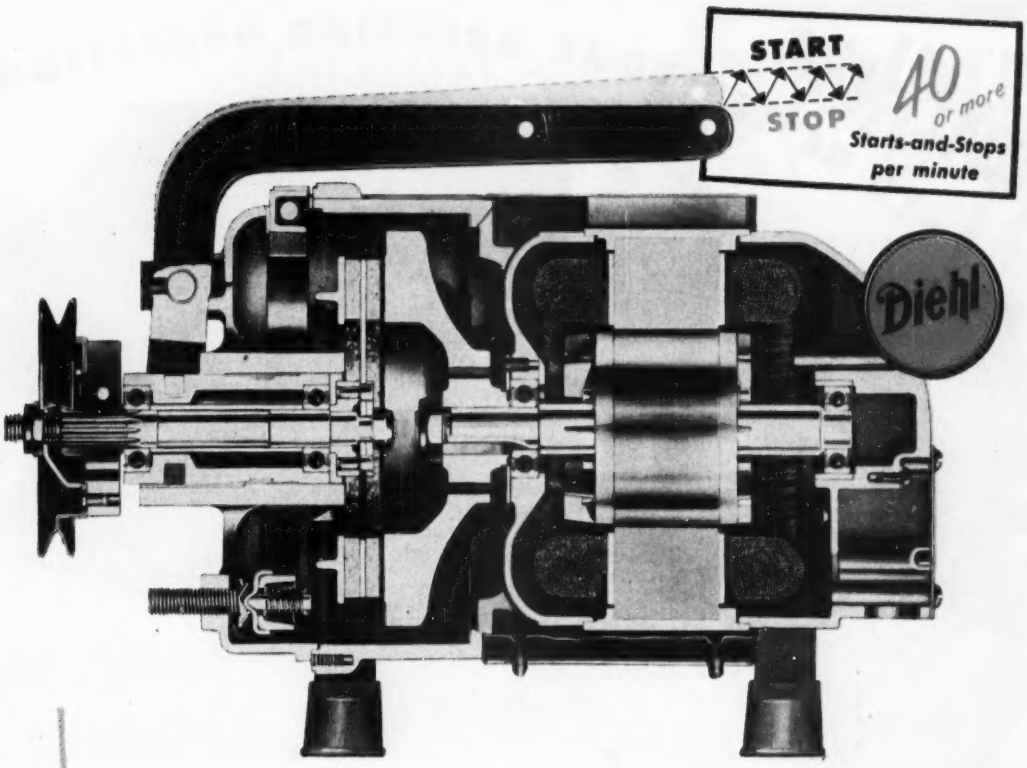

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Unequalled for Repeated Start-Stop Machine Operation

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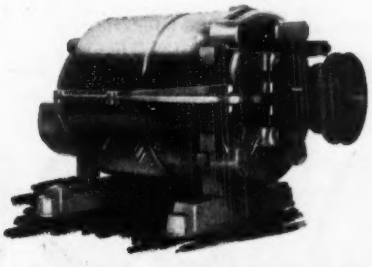
HIGH INERTIA FLYWHEEL • TOTALLY ENCLOSED MOTOR

Repeated, rapid start-stop machine operation, impractical with conventional motor drives, is now obtainable with Diehl Power Transmitters. Forty or more starts and stops per minute, hour after hour, are commonplace with these drives. Many manufacturers have made substantial increases in machine output by the shortening of acceleration and deceleration waiting periods.

In one compact unit, the Diehl Power Transmitter incorporates a totally-enclosed fan-cooled ball bearing motor; a high inertia, dynamically balanced flywheel; a positive short-throw, lever-actuated clutch brake assembly. The actuation may be controlled mechanically or electrically.

These Power Transmitters are now used extensively on machine tools, textile machinery, winding and spooling equipment, conveyors and many other types of machinery where repeated starting and stopping is required. In countless instances, the use of Diehl Power Transmitters has made it possible to simplify machines, reduce costs, improve operation, save space and eliminate over-motoring solely for acceleration. Many of *your* troublesome machine drive problems may be solved with Diehl Power Transmitters.



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☐ Type "J" Power Transmitter Bulletin No. CE-3303.
☐ Consolidated Motor Catalog and Price List No. CE-3310

Name_____

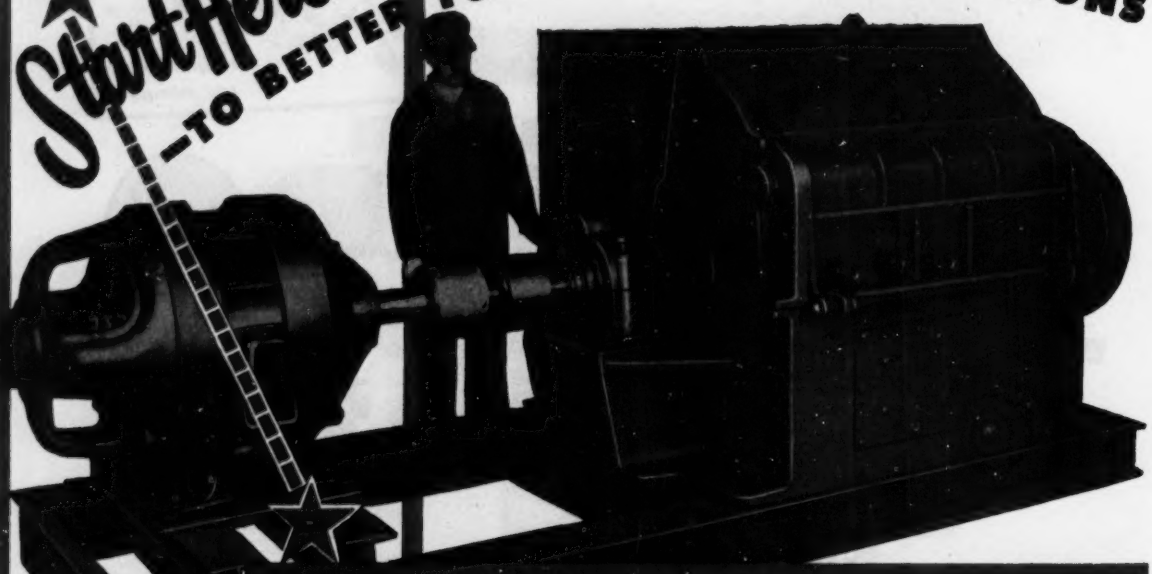
Company_____

Street_____

City_____ State_____

OTHER INTEGRAL AND FRACTIONAL HORSEPOWER MOTORS ARE AVAILABLE IN A WIDE RANGE OF TYPES AND SIZES

Start Here —TO BETTER YOUR GRINDING OPERATIONS



WILLIAMS Heavy Duty HAMMER MILLS

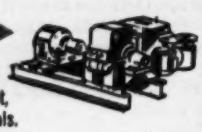
OTHER WILLIAMS EQUIPMENT

▲ **ROLLER MILLS**
—IMPACT and DRYER MILLS
—for fine grinding to 400 mesh or micron sizes

▲ **AIR SEPARATORS**
— any type; for precision control and high production in fine grinding

VIBRATING SCREENS
1 to 3 decks, — in any size for any job, open or enclosed.

HELIX-SEAL MILLS
—for dust-free grinding, and for wet, sticky, greasy materials.



Also: COMPLETE "Packaged" PLANTS for crushing, grinding, separating.

★ **INCREASE YOUR OUTPUT**
★ **IMPROVE PRODUCT QUALITY**
★ **REDUCE YOUR COST-PER-TON**

★ No matter how tough your grinding, crushing or shredding job—no matter what the material; mineral, vegetable, chemical or animal—there's a Williams Hammer Mill engineered especially to get the finished product you want in a single operation—A SAVING UP TO 50% IN PRODUCTION COSTS! Extra primary and secondary crushers are unnecessary—foundations and buildings for additional machines, drives, conveyors and other equipment are eliminated—A SAVING UP TO 75% IN EQUIPMENT COST!

Many Williams exclusive design and construction features assure greater accuracy to meet the most difficult product specifications—and promise continuous satisfactory performance under the most severe operating conditions with an absolute minimum of maintenance.

Consult with Williams about increasing your grinding output and reducing your costs. Tell us about your operation at the time you Write For Complete Catalog.

★ **WILLIAMS TESTING LABORATORY WILL HELP YOU**
Complete testing and research facilities are maintained by Williams to find the right answers for you on every size reduction problem. Write for information.

WILLIAMS PATENT CRUSHER & PULVERIZER CO.
2706 N. 9th St. ★ ★ ★ St. Louis 6, Mo.

WILLIAMS

CRUSHERS GRINDERS SHREDDERS

OLDEST AND LARGEST MANUFACTURER OF HAMMER MILLS IN THE WORLD

COMPLETELY ASSEMBLED
FACTORY ADJUSTED
PRE-LUBRICATED

SEALED

—ready to mount on the shaft!

DODGE-TIMKEN *America's Quality Pillow Block*

Extra measures are taken to build superior quality into Dodge-Timken Bearings; and extra precautions are taken to keep that quality *intact*—from the factory to distributor to you to your machines.

These bearings are sealed in manufacture—an integral part of Dodge-Timken design. Their inbuilt precision is protected *both on and off the shaft.* That is one reason why they easily deliver a minimum of 30,000 hours of service. Want evidence? Look around you. No other pillow block is so widely used on the nation's tough jobs. Dodge-Timken dependability has been proved in *millions* of installations.

There are 5 types of Dodge-Timken Pillow Blocks for all types of service, in shaft sizes from 1 3/16" to 10". Also Dodge-Timken Hanger Bearings, Flange Bearings, Take-ups.

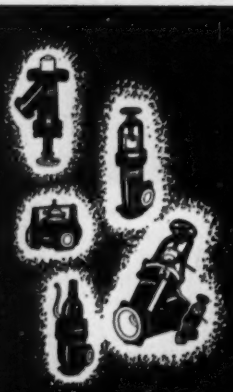
DODGE MANUFACTURING CORPORATION, 200 Union St., Mishawaka, Indiana

DODGE
of Mishawaka, Ind.

CALL THE TRANSMISSIONEER, your local Dodge Distributor. Factory trained by Dodge, he can give you valuable assistance on new, cost-saving methods. Look for his name under "Power Transmission Machinery" in your classified telephone directory, or write us.

Easy working and long life in chemical atmospheres ...for the Lapp Valve

Non-ferrous working parts in the Lapp Valve eliminate freeze-ups from scales of corrosion. Threaded stud, yoke bushing and nuts, and plug cap are all brass or bronze, which keep the valve smoothly operative in all but the most unusual conditions of chemical atmosphere. Flange, yoke and gland are of high strength malleable or ductile iron, and are protected with baked-on Epon-base acid-proof paint. Flanges are permanently bonded to porcelain or armor with acid-proof resin cement. *Write for bulletin with complete description, characteristics, and specifications. Lapp Insulator Co., Inc., Process Equipment Division, 306 Wendell Street, LeRoy, New York.*

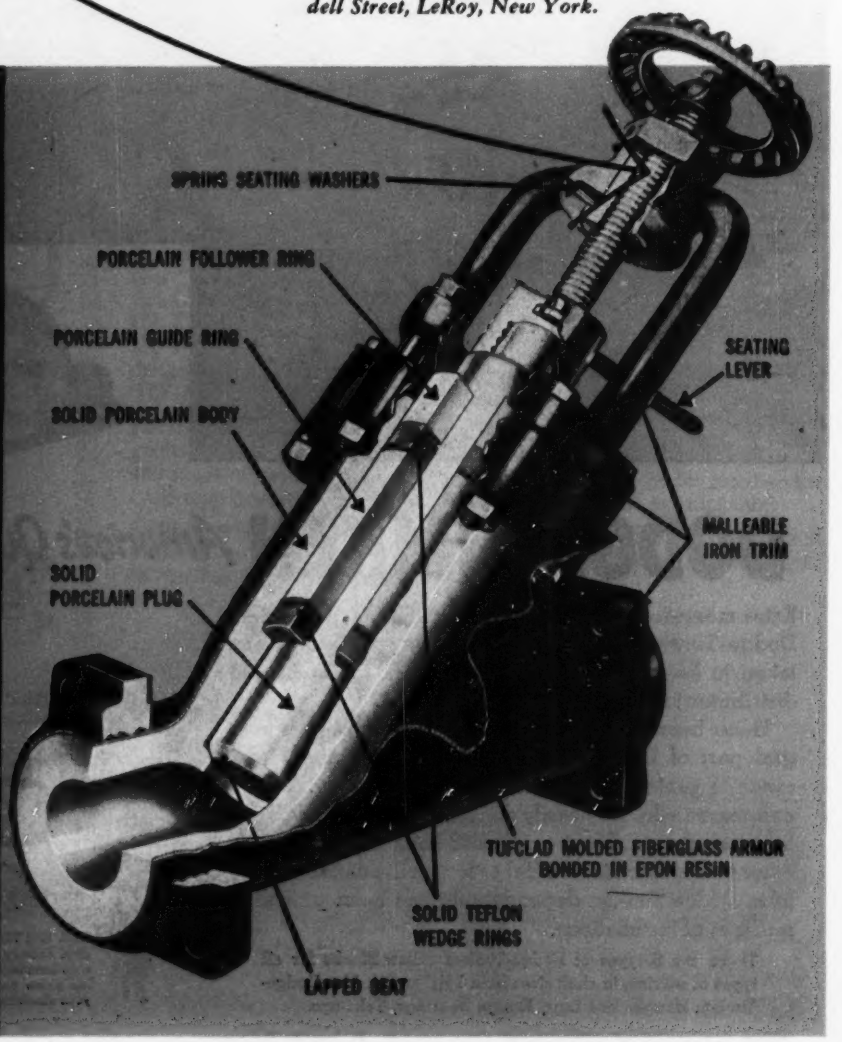


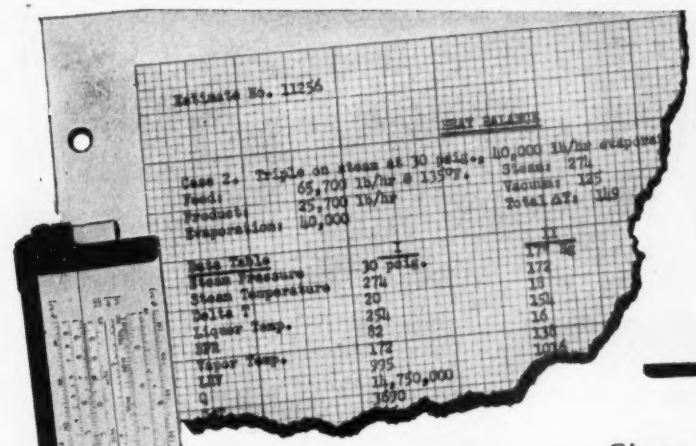
Y valves, angle valves, flush valves, safety valves and plug cocks of Lapp Porcelain have standard bolt-circle flanges for easy connection to all piping and equipment.

Lapp

PROCESS EQUIPMENT

Chemical Porcelain Valves
Pipe • Raschig Rings • Pulsafeeder
Chemical Proportioning Pumps

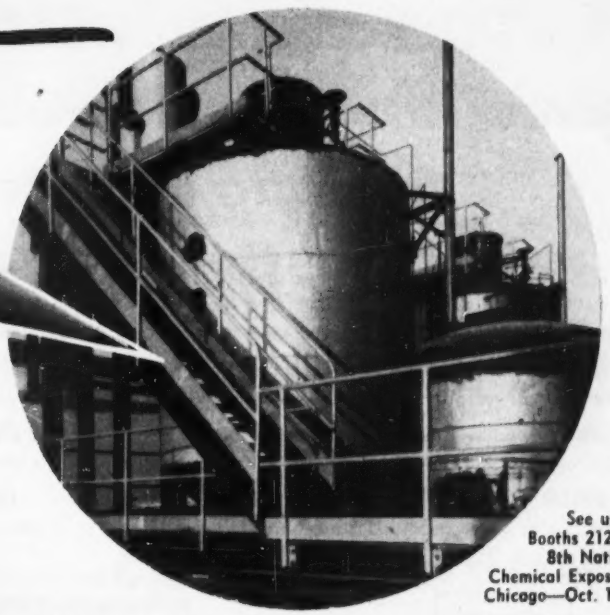




The right start here

cuts costs here—

Given only the process conditions, GOSLIN-BIRMINGHAM Engineers are prepared to design chemical process installations for your plant and take *full responsibility* for the process, workmanship and material. This complete responsibility, inside one fence, under one roof and by one organization . . . from slide rule to freight car . . . assures you of the ultimate in maximum efficiency at minimum cost!



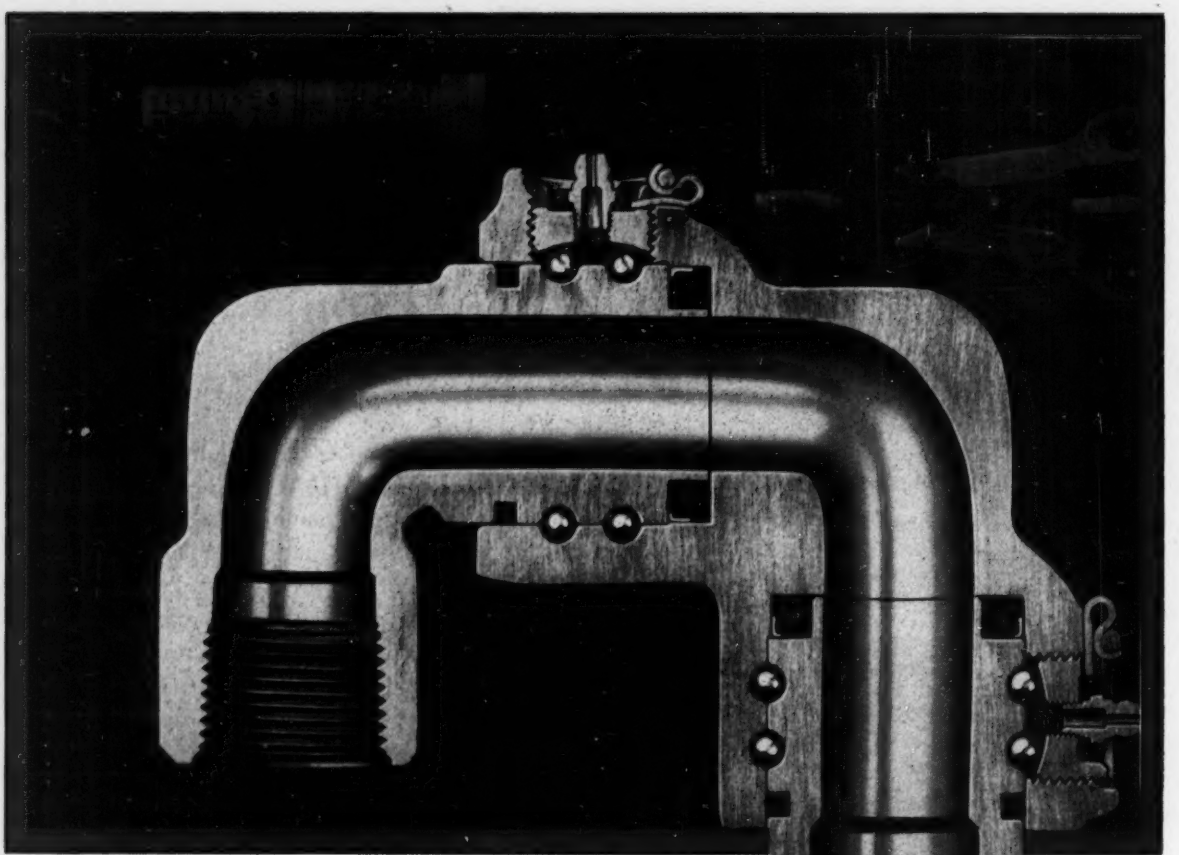
Single effect, long tube re-circulating type of evaporator of stainless steel construction for ammonium nitrate service at The Spencer Chemical Co. Plant Pittsburg, Kansas

See us at Booths 212-213 8th National Chemical Exposition Chicago—Oct. 12-15

G-B ENGINEERS are at your service any time to discuss your requirements . . . without cost or obligation.

GOSLIN-BIRMINGHAM MANUFACTURING CO., INC.

BIRMINGHAM · ALABAMA



precision engineered for long service

CHIKSAN Ball-Bearing Swivel Joints are precision engineered like a fine watch to give unlimited flexibility and unlimited service in the conduct of fluids, gases and liquids.

CHIKSAN is the originator and largest exclusive manufacturer of ball-bearing swivel joints in the world today.

CHIKSAN produces packing designs for specific service requirements, assuring constant torque at any given pressure.

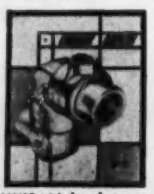
CHIKSAN has acquired a world-wide recognition for highest quality of product and lowest maintenance costs.

CHIKSAN has over a quarter of a century of "know-how" in the design, manufacture and successful scientific application of ball-bearing swivel joints in industry.

CHIKSAN offers the widest range of styles, sizes and pressures available for every major industrial use today.

CHIKSAN has complete nation-wide coverage of its products and applications by qualified field service engineers.

CHIKSAN will custom engineer for you the solution to any problems involving the transport of fluids, gases and liquids.



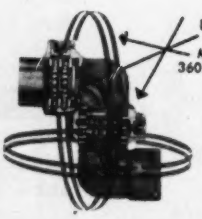
Write CHIKSAN for latest INDUSTRIAL CATALOG—G-4 Dept. 9-CE

Supply and Service of CHIKSAN Ball-Bearing Swivel Joints is always as near as your telephone.

The Flow of Enterprise Relies on

CHIKSAN

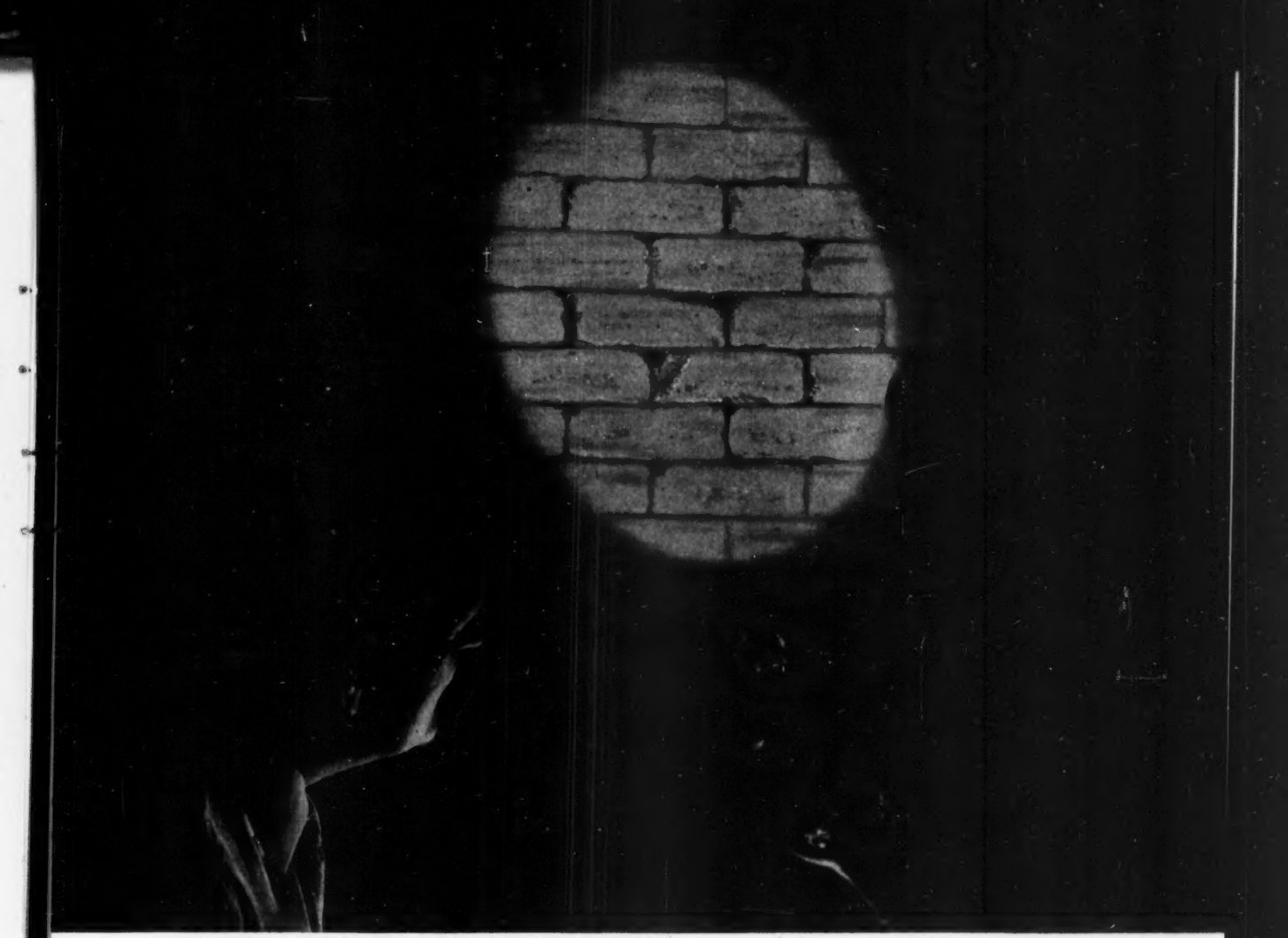
Ball-Bearing Swivel Joints



CHIKSAN Ball Bearing Swivel Joints are THE NEW TOOL of Modern Industry with full 360° rotation in 1, 2, and 3 planes. Over 1,000 different types, styles, and sizes have been developed for pressures and services from 28" vacuum to 15,000 psi and for temperature ranges from minus 70° to a plus 500° F. with packing materials for each specific service.

CHIKSAN COMPANY • BREA, CALIFORNIA • Chicago 3, Illinois • Newark 2, New Jersey

Well Equipment Mfg. Corp. (Division), Houston 1, Texas • Subsidiaries: Chiksan Export Co., Brea, Calif.; Newark 2, N. J. • Chiksan of Canada Ltd., Edmonton, Alta.



Why accept frequent furnace repairs and production losses as "routine"? Today, there's one . . .

Sure way to avoid shutdowns

WHAT CAUSES MOST REFRACTORY FAILURES? Usually one small area is at fault. A spot that had to take more abuse than the rest of the furnace . . . and couldn't. Couldn't because it was made of the same refractories as the rest of the furnace. Couldn't because it was not protected by materials *specifically designed* to resist corrosion . . . or flame impingement . . . or erosion . . . or extreme heat . . . or whatever combined conditions caused the localized failure.

That's where CARBORUNDUM's super refractories fit in. These products are "custom designed" to do what's above-and-beyond other refractories. They are the "armor plate" agents, designed to make emergency furnace breakdowns a rarity.

THEY ARE ALSO ENTIRELY DIFFERENT. Some of their properties have no inherent connection with ordinary refractories. For example, the diamond-like hardness of silicon carbide, which gives it superior wear resistance. Or the corrosion resistance of electric furnace mullite. Or the chemical stability of aluminum oxide.

They're also very different, one from another. Some conduct heat very rapidly. Others insulate. Some are made of bonded grain, others of bubbles or hollow spheres bonded together. Still others are cast, like metals, into an impervious, ivory-like structure. But all are inherently strong, resistant to extreme heat, and highly durable. And each, in its place, can pretty much eliminate emergency shutdowns, and extend on-line time.

WE'D LIKE TO WORK WITH YOU toward this end. Our engineers know what materials to apply—and where. For theirs is the experience of the world's largest supplier of super refractories. As a starter, send the coupon.

CARBORUNDUM
Registered Trademark

Dept. H-94, Refractories Division
The Carborundum Co., Perth Amboy, N. J.

☐ As a starter, send literature only.

☐ I'd like first-hand information. Please phone for appointment.

Name _____ **Position** _____

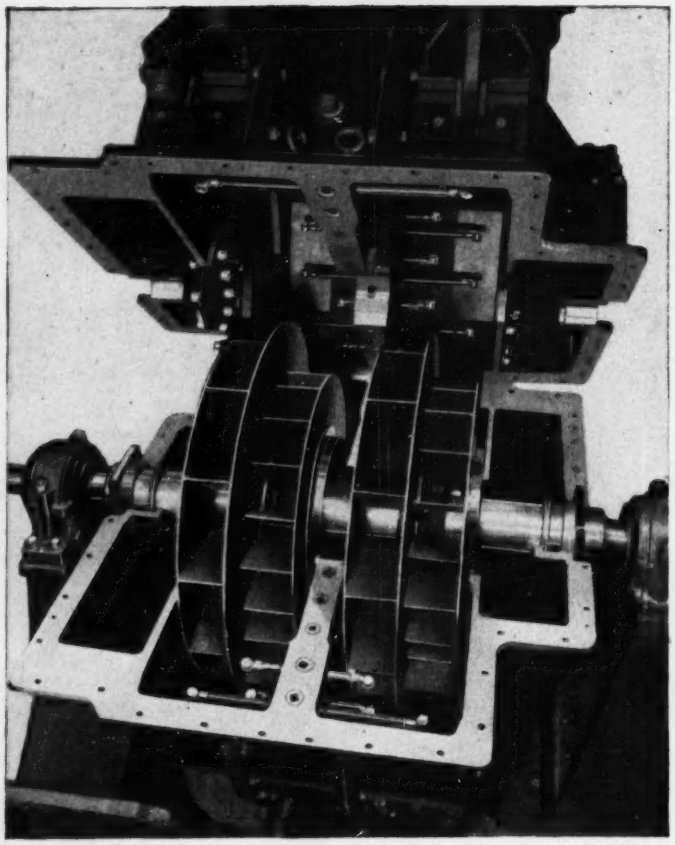
Company _____

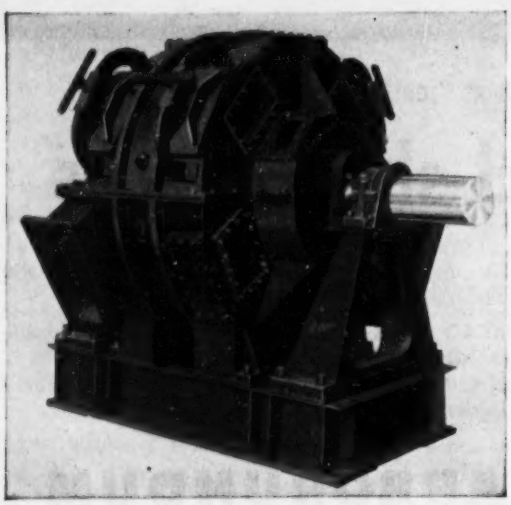
Address _____

HOW THIS COMPACT

CYCLONIC WET SCRUBBING CHAMBER

handles your most exacting gas cleaning jobs





FOR REMOVING TAR VAPOR — LAMPBLACK — METALLIC FUME — "Buffalo" Rotary Multi-Stage Gas Scrubbers have proven the ideal answer to low-volume requirements in the metallurgical and processing industries. Write for Bulletin AP-425 for details on these extremely sturdy units for high cleaning efficiency.

"BUFFALO" ROTARY MULTI-STAGE GAS SCRUBBER

In the above photo of a "Buffalo" Rotary Multi-Stage Gas Scrubber with upper casing lifted, you see a cyclonic gas scrubbing chamber which is ideal for removing easily wetted or slightly water-soluble dust particles. Where tar vapor, lampblack or metallic fumes are present to the extent of 5 to 10 grains per cu. ft. of gas, cleaning effects down to .006 grains per cu. ft. are being averaged in use.

Gas with its dust content is sprayed as it enters one side of the wheel. Wet scrubbing action takes place as the wheel revolves. Cleaned gas is discharged from the "inlet" of the other wheel. This "Buffalo" Scrubber is the only small-space unit to handle many of today's requirements for low but toxic initial loadings. You are urged to write our Engineering Sales Representatives or our Engineering Dept. concerning your specific air or gas cleaning problem.

"Buffalo"

BUFFALO FORGE COMPANY

501 BROADWAY BUFFALO, N.Y.

Publishers of "Fan Engineering" Handbook

Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

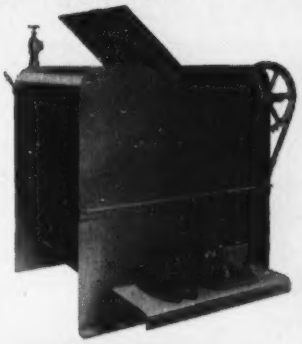
Sales Representatives in all Principal Cities

VENTILATING AIR CLEANING AIR TEMPERING INDUCED DRAFT EXHAUSTING FORCED DRAFT COOLING HEATING PRESSURE BLOWING

assure high accuracy—
enjoy efficiency—

specify INFILCO chemical feeding equipment

No Corners or "Dead-Spaces" with INFILCO Wet Chemical Mixers and Feeders for Volumetric Feeding



The preparation of a uniform slurry or suspension of sparingly soluble chemicals and the volumetric feeding of the prepared material is combined in one continuous automatic process in INFILCO Chemical Mixers and Feeders.

Because of the unique vertical agitation principle of operation, liquid circulates with an *up and down* motion in the mixer . . . thus eliminating stratification. The mixture is discharged by chemical measuring cups which revolve with the set of agitators at the delivery end. There are no corners or "dead spaces" in the half-round tank where solids can collect . . . there's no need for daily or weekly cleanouts. For complete detailed information request Bulletin 350-D.

Freedom from Mechanical Difficulties with INFILCO'S Type "E" Dry Chemical Feeder

The type "E" Feeder is a non-clogging feeder which delivers a measured amount of chemical by extrusion off both ends of a stainless steel pan as it follows a reciprocating and tipping motion. A linear setting is provided for adjusting the rate of feed throughout the entire capacity range of the feeder. Either constant rate or automatic proportional feeding may be furnished and the feeder may be equipped with a counter to total the number of pounds fed. Results are comparable to a gravimetric feeder without the expense, complications and maintenance of such feeders. The simple operating principle assures high accuracy, efficiency and freedom from mechanical difficulties. Request Bulletin 215-A for complete information.

Simple Operation of the Neusel Feeder is Your Solution for Solution Feeding

This PNEUmatically activated SOLution full-view plastic constructed pump, with no metal surface exposed to the liquids handled, permits accurate feeding of corrosive solutions. Self-priming and extremely flexible in its application to solution feeding problems the NEUSOL® Feeder, with a minimum of moving parts in the feeder and only one in the pump itself, is simple to operate and maintain. The rate of feed is determined by the position of the rate setter dial which may be set for any value between 0% and 100% of the feeder capacity. For descriptive literature request Bulletin 340.

Write for case histories and illustrated bulletins

INFILCO **INFILCO INC.** *Tucson, Arizona*

Plants in Chicago and Joliet, Illinois

FIELD OFFICES IN 33 PRINCIPAL CITIES IN THE U.S., CANADA AND MEXICO

INFILCO INC. BOX 5033, TUCSON, ARIZONA

We are interested in mixing and feeding

_____
(name chemicals)

in one continuous and automatic process for

_____
(name process liquid)

Please send bulletin ☐ 350-D ☐ 215-A ☐ 340

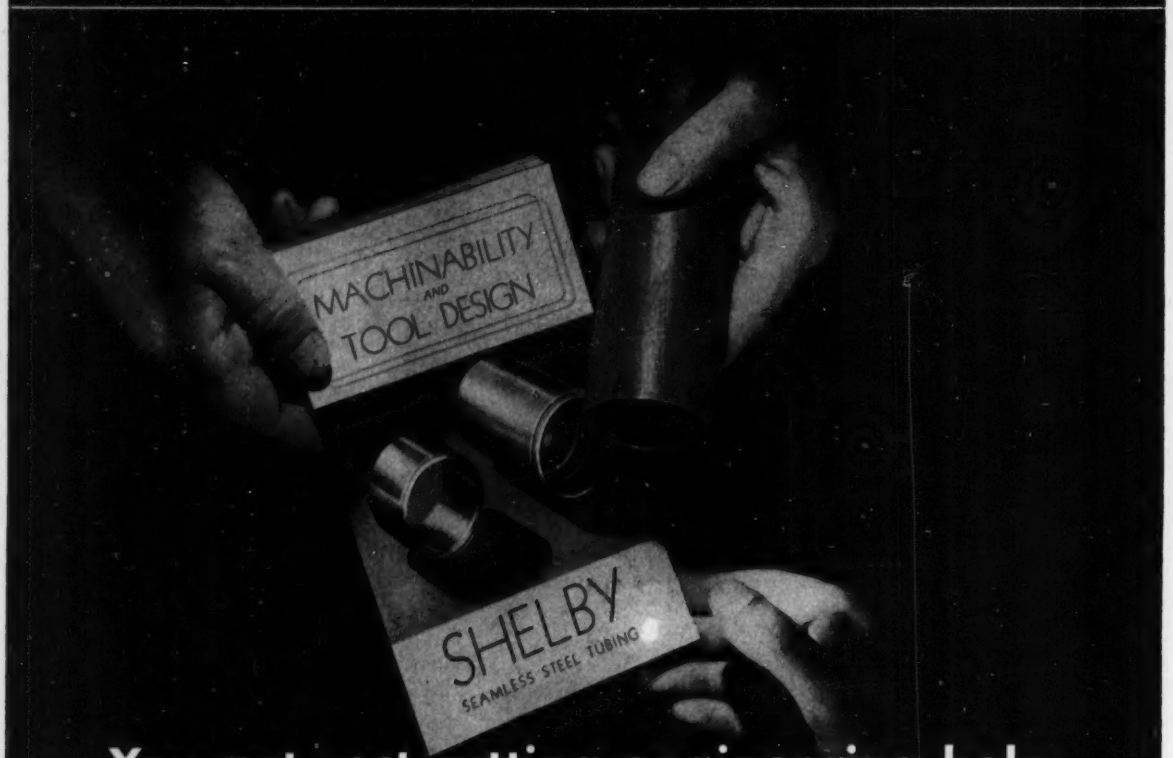
NAME _____ TITLE _____

COMPANY _____

STREET _____

CITY _____ ZONE ____ STATE _____

WHY IT PAYS TO BUY MECHANICAL TUBING FROM US



You get cost-cutting engineering help

● Our wide experience with all types of tubing problems has saved a lot of money for a lot of our customers. For example, we can often find a less costly type of tubing that will do a job as well or even better than a type that might cost more, but would not be "best" in that particular application.

You too may benefit from our accumulated "know-how." For no matter what type or size job you have, you can always depend upon us for thorough, up-to-date technical assistance.

And our more-than-complete tubing stocks—we carry 531 sizes of Shelby Seamless Tubing—means that you will get fast delivery of exactly the type you want. It's all top quality tubing too . . . manufactured by the National Tube Division of United States Steel.

So let *us* carry the costly, cumbersome tubing inventory that can meet your every requirement . . . competently, quickly. Call us when you need: mechanical tubing, round and square, seamless and welded; boiler tubing, pressure tubing and pipe; stainless steel tubing, seamless and welded, and stainless pipe.

TRIPLE SECURITY

What you want
When you want it
At the right price

U. S. STEEL SUPPLY
DIVISION

General Offices
208 So. La Salle St., Chicago 4, Ill.

Warehouses and Sales Offices
Coast to Coast

USS SHELBY MECHANICAL TUBING UNITED STATES STEEL

UNITED STATES STEEL

Built for SEVERE DUTY

frequent starting · inching · reversing · dynamic braking

ALLIS-CHALMERS

Type 256

AIR CONTACTOR

MOTOR CONTROL

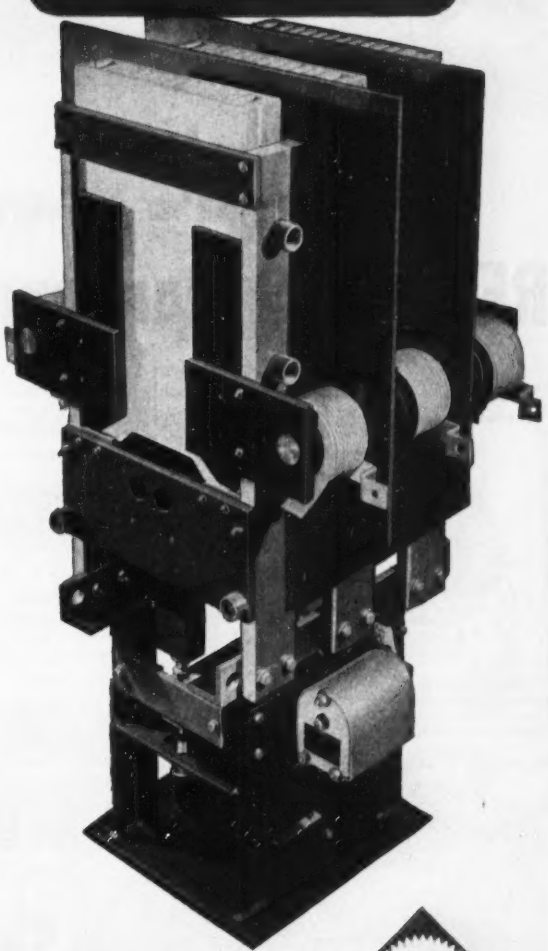
Durability and long-term dependability were given prime consideration in the design of the Allis-Chalmers Type 256 air-break contactor. As a result, the roughest repetitive duty becomes routine — contact operations are actually numbered in the millions with a minimum of servicing.

DESIGN FEATURES

By utilizing a simple vertical motion and double break contacts, troublesome maintenance factors, such as mechanical linkages, turning shafts, shaft bearings and flexible leads, have been eliminated. From the operation standpoint, two gaps in series cut arc voltage in half. Rapid arc extinction is further facilitated by magnetic blowouts at each gap, operating with arc chutes designed to take full advantage of dual blowouts.

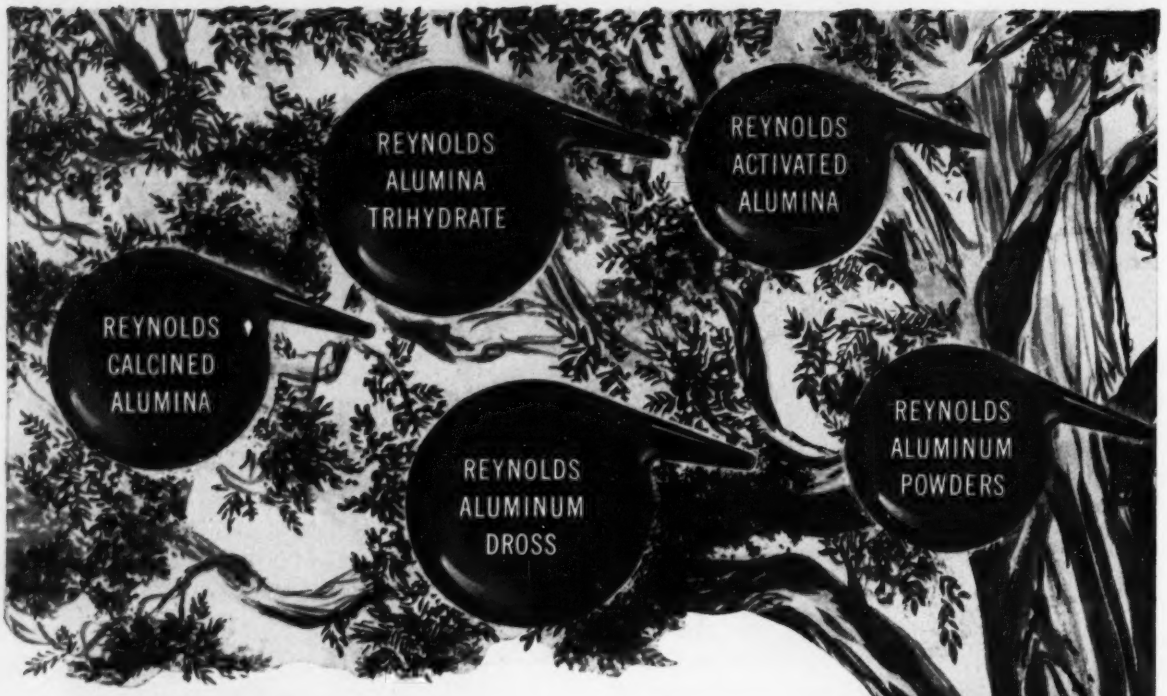
In Allis-Chalmers Type H high voltage starters, Type 256 air-break contactors — along with meters, overload relays, current limiting fuses, auxiliary switches — are coordinated to meet heavy duty demands — to provide high capacity interruption and complete protection for man, motor and machine. For complete information see your nearby A-C representative, or write Allis-Chalmers, Milwaukee 1, Wisconsin. Ask for bulletins 14B6410B and 14B7303.

A-4325



ALLIS-CHALMERS

A-C ALLIS-CHALMERS



A family tree that's really growing...

REYNOLDS Aluminum CHEMICALS

Springing from a firm foundation of bauxite mines, Reynolds offers a growing family of high quality aluminum chemicals. If your products or processes are included below, look to Reynolds Chemicals.

Alum, chemicals, catalysts, glass: Reynolds Organic Free Alumina Trihydrates are whiter and purer than any other similar products.

Air or gas drying: Reynolds Activated Alumina is a high quality and efficient desiccant.

Abrasives, frits, glazes, refractories: Low cost Reynolds Calcined Aluminas may be able to replace more expensive aluminas.

Paints, explosives, reducing agents: Investigate Reynolds wide range of Aluminum Powders.

Test samples of any of these chemicals are available for your evaluation.

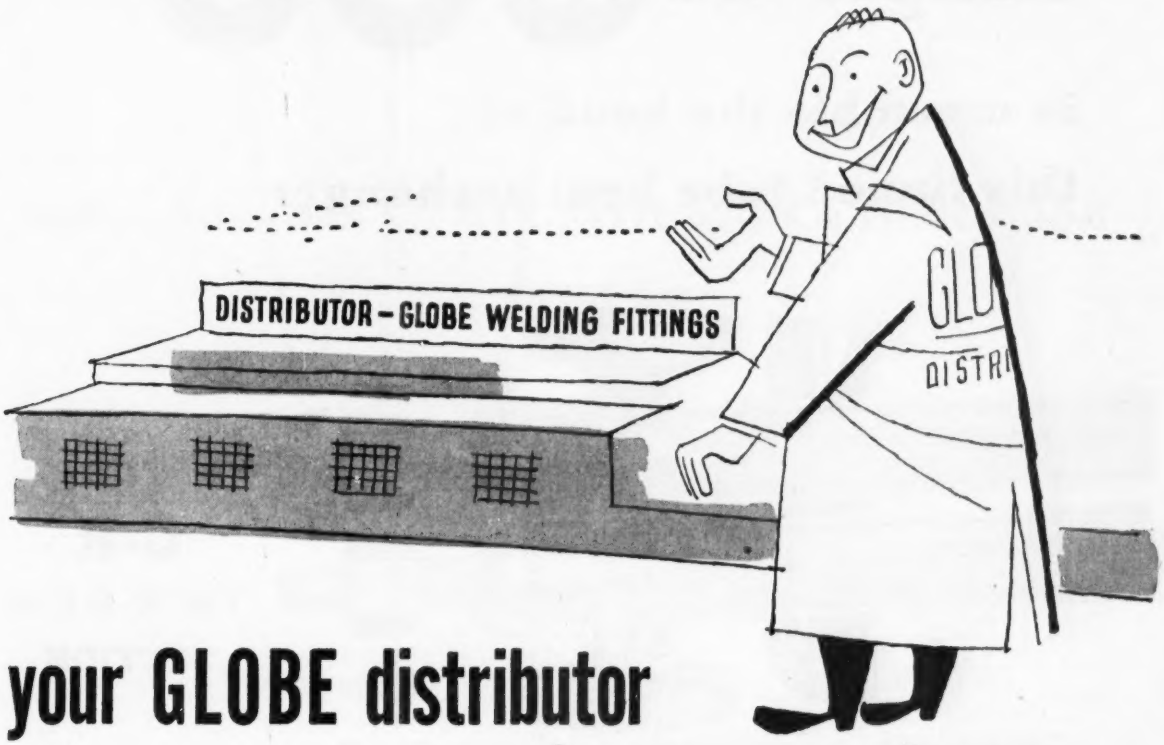
Write for free descriptive brochure "Reynolds Aluminum Chemicals," Reynolds Metals Company, 2567 South Third Street, Louisville 1, Kentucky.

A fresh approach to new applications and new solutions to your problems is available from Reynolds chemical and engineering specialists . . . in the field and home office.

REYNOLDS CHEMICALS

FROM THE PRODUCERS OF REYNOLDS ALUMINUM

When you need welding fittings...



your GLOBE distributor can be your warehouse

Among the many advantages you get by dealing with your Globe Welding Fittings distributor is the fact that you can hold inventory to a sensible minimum and conserve stockroom space.

That's because he carries a wide range of types and sizes of welding fittings in stock. Thus, your welding fittings supply is no farther away than the nearest phone. At the same time you can simplify much of the paperwork usually required for extensive inventory control, purchasing and bookkeeping.

Call your Globe distributor now — get the facts on the many ways he can serve you . . . help you save time and money.

GLOBE STEEL TUBES Co., Milwaukee 46, Wis.

For the name of your Globe distributor, call any of these District Offices.

Chicago • Cleveland • Denver • Detroit • Glendale, Calif. • Houston
New York • Philadelphia • St. Louis • San Francisco

Only Globe — among manufacturers of seamless Welding Fittings— produces its own seamless tubes. Only Globe offers you precision-processed fittings through every step of production — from billet to tube to fitting.

GLOBE
PRECISION PROCESS

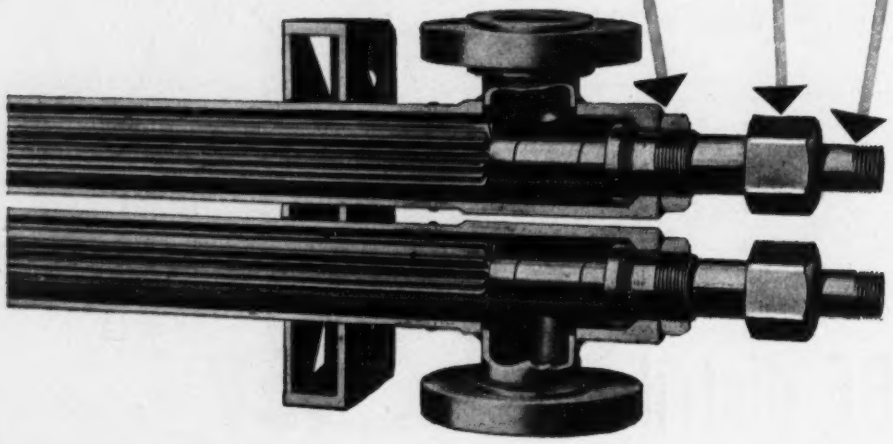
SEAMLESS WELDING FITTINGS

GLOBE TUBES

Producers of Globe seamless stainless steel tubes— Gloweld welded stainless steel tubes — alloy — carbon — seamless steel tubes — Globeiron (high-purity ingot iron) seamless tubes — Globe Welding Fittings.

Simple as A B C

to assemble the head of this finned tube heat exchanger



THE G-R TWIN G-FIN® SECTION

A **CONE PLUG LOCK NUT**

B **UNION NUT**

C **MALE TAILPIECE**

These are the only parts in the complete head assembly of the G-R Twin G-Fin Section. Similar simplicity is inherent in every other feature, such as:

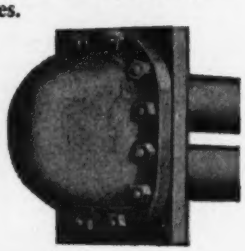
Simple Design—Consists essentially of a pipe within a pipe, without the complications of tube sheets, baffles and internal joints.

Simple Installation—These lightweight, standard, interchangeable units can be easily stacked and connected in series or parallel for the desired capacity and temperature ranges.

Simple Maintenance—Removable elements simplify cleaning of exteriors. There are no stuffing boxes to cause trouble, no rolled tube joints. Maintenance is low.

Simple Conversion—These units can be readily converted from one service to another. They are available in non-ferrous as well as ferrous alloys — can be used as heaters, coolers, condensers or heat exchangers for practically all liquids, vapors and gases.

Domed Shell Cover—This type of shell cover is particularly rugged, yet weighs only 17 pounds for the small sections and 43 pounds for the standard high capacity sections.

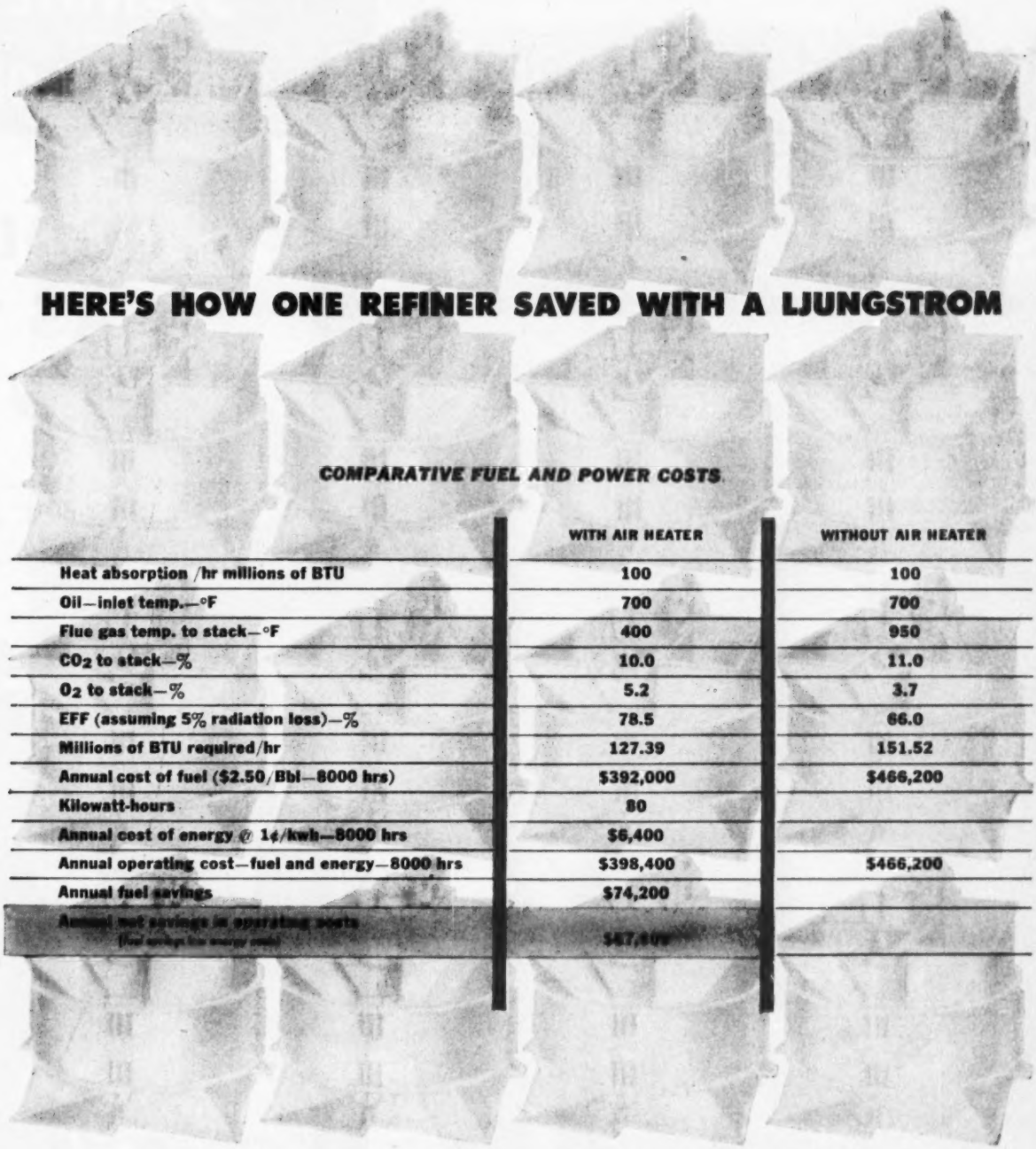


70,000 Trouble-Free Installations

THE GRISCOM-RUSSELL CO., MASSILLON, OHIO

G-R HEAT TRANSFER APPARATUS **Twin G-Fin Section**

GR-337



HERE'S HOW ONE REFINER SAVED WITH A LJUNGSTROM

COMPARATIVE FUEL AND POWER COSTS

	WITH AIR HEATER	WITHOUT AIR HEATER
Heat absorption /hr millions of BTU	100	100
Oil—inlet temp.—°F	700	700
Flue gas temp. to stack—°F	400	950
CO_2 to stack—%	10.0	11.0
O_2 to stack—%	5.2	3.7
EFF (assuming 5% radiation loss)—%	78.5	66.0
Millions of BTU required/hr	127.39	151.52
Annual cost of fuel ($2.50/Bbl—8000 hrs)	$392,000	$466,200
Kilowatt-hours	80	
Annual cost of energy @ 1¢/kwh—8000 hrs	$6,400	
Annual operating cost—fuel and energy—8000 hrs	$398,400	$466,200
Annual fuel savings	$74,200	
Annual net savings in operating costs (fuel savings less energy costs)	$67,800	

Wherever you burn fuel, you need LJUNGSTROM

Listed in this table are comparative fuel and power costs for operating two identical deFlorez stills, one with and one without a Ljungstrom® Air Preheater. Operating costs *without* the Ljungstrom reflect performance with a convection bank of tubes.

Remember: the initial cost of a Ljungstrom installation often is more than offset by the savings reflected in eliminating the convection bank.

Remember, too — operating savings are only part of the story. Higher flame temperatures developed through the use of preheat increases heat transfer to oil tubes — thereby increasing throughput.

The Air Preheater Corporation 60 East 42nd St., New York 17, N. Y.

12 years of the right oil keeps air compressor . . . .

■ Keeping this air-compressor trouble-free and always on the job is a "must" at General Chemical's fluorspar mine located near Boulder, Colorado. Under rough conditions of fluctuating loads the compressor supplies air for air tools, rock drills, slushers and other vital mining tools.

Constant operation calls for an oil that will keep wear to a minimum . . . and assure trouble-free compressor out-put to keep these tools working.

In a recent twelve year stretch, STANOIL #31 was the oil relied on to keep this unit on the job.

At the end of this period the engine was taken down for inspection. With this hard-working oil assuring day-in day-out protection these were the findings. There were no carbon deposits and no cylinder wear. Protection had been so thorough that the rings showed *no signs of wear whatsoever!* In fact, they were in such like-new condition that they were put back into use!

STANOIL
TRADE MARK
Industrial Oil

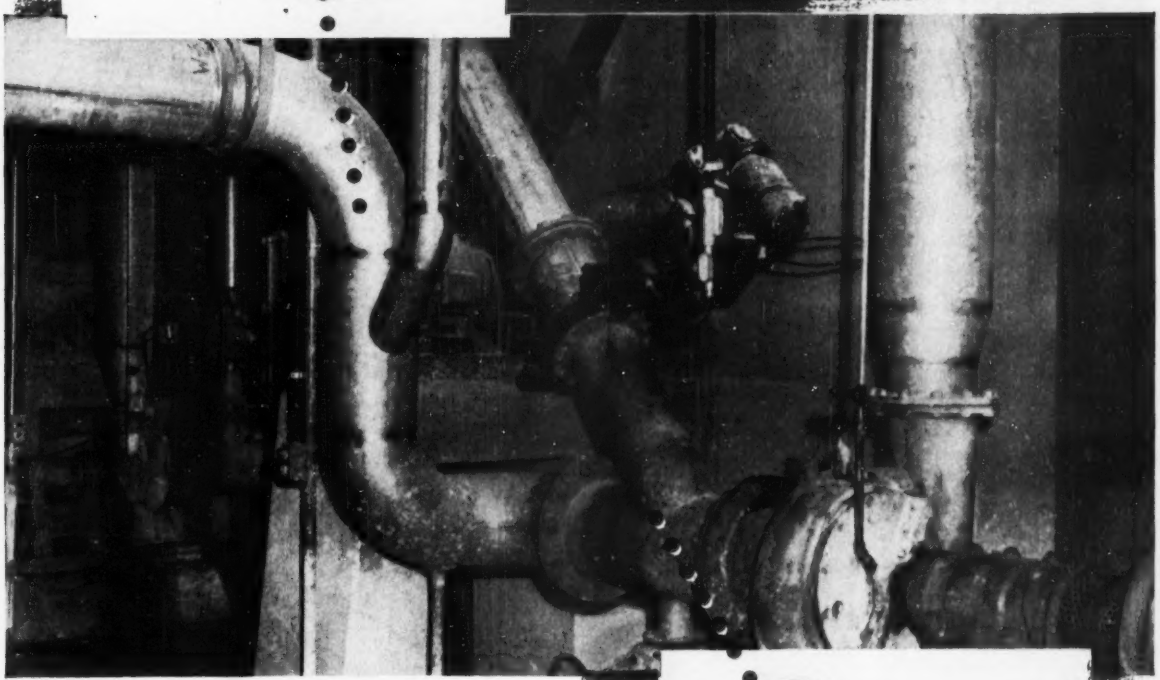
. . . GOOD AS NEW!

This is Standard Oil's E. K. Arnston who helped General Chemical save time and money with superior lubrication. For help like this call your nearest Standard Oil office or write to Standard Oil, Chicago.

STANDARD OIL COMPANY (*Indiana*)

STANDARD

Complex Piping Problems easily solved with Standard TRI-CLOVER Stainless Steel Fittings



NEKOOSA-EDWARDS

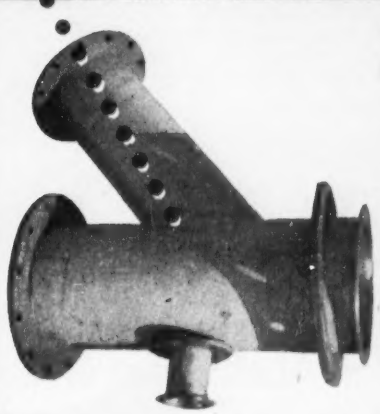
Multi-Million Dollar Expansion Program Includes TRI-CLOVER Fittings

The assemblies shown here are part of the stainless steel fittings and fitting assemblies manufactured by Tri-Clover to meet the requirements of Nekoosa-Edwards Paper Company. These particular units are part of the Vortrap assemblies, and are composed of standard Tri-Clover fittings factory-welded into assemblies and then fully annealed to provide maximum corrosion-resistance.

By utilizing "standard" fittings, together with Tri-Clover's specialized experience in the expert welding of stainless steel fittings, pipe and tubing, mills like Nekoosa-Edwards are assured of highest quality materials and workmanship, with *full* corrosion-resistance throughout.

Experience and craftsmanship make the big difference in the production of long-lasting, fully corrosion-resistant assemblies. That's why more and more mills and plants in the chemical-process industries are specifying TRI-CLOVER . . . for the highest quality stainless steel fittings, pipe, tubing and pumps.

Write for further details.



See your nearest TRI-CLOVER DISTRIBUTOR
EXPORT DEPARTMENT, 8 So. Michigan Ave., Chicago 3, U.S.A.

LADISH CO.
Tri-Clover Division
KENOSHA WISCONSIN

THE Complete LINE

HARSHAW FLUORIDES WORK

like magic

BORON TRIFLUORIDE

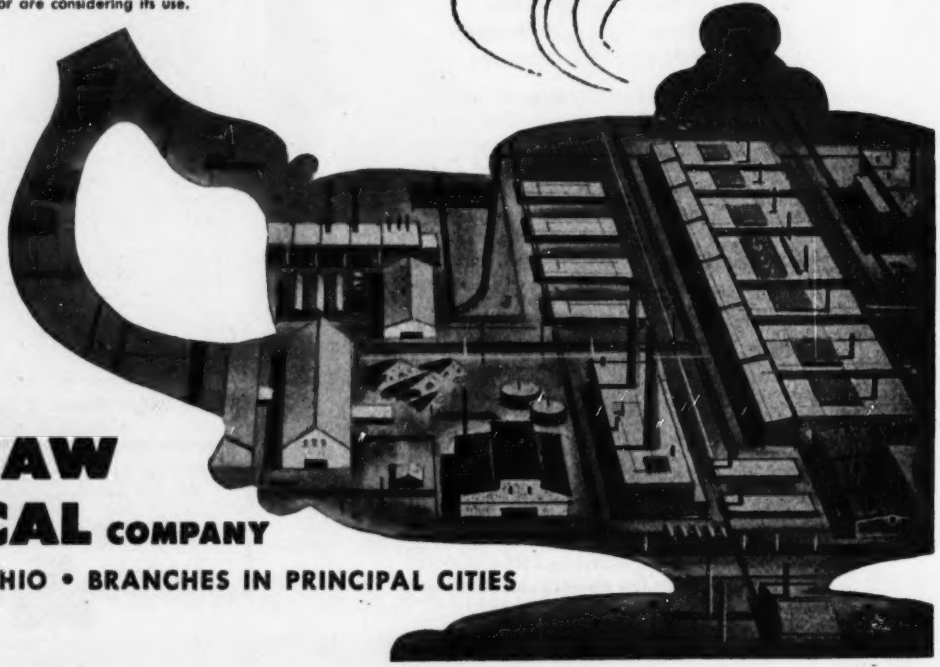
HYDROFLUORIC ACID

• ANHYDROUS • AQUEOUS

Here is an additional group of production-controlled, high-quality fluorides:

- Ammonium Bifluoride
- Ammonium Fluoborate
- Antimony Trifluoride Sublimed
- Barium Fluoride
- Bismuth Fluoride
- Boron Trifluoride
- Boron Trifluoride Complexes
- Chromium Fluoride
- Copper Fluoborate
- Fluorboric Acid
- Fluorine Cells
- Fluorinating Agents
- Frosting Mixtures
- Hydrofluoric Acid Anhydrous
- Hydrofluoric Acid Aqueous
- Hydrofluosilicic Acid
- Lead Fluoborate
- Metallic Fluoborates
- Potassium Bifluoride
- Potassium Chromium Fluoride
- Potassium Fluoborate
- Potassium Fluoride
- Potassium Titanium Fluoride
- Silico Fluorides
- Sodium Fluoborate
- Tin Fluoborate
- Zinc Fluoborate
- Zinc Fluoride

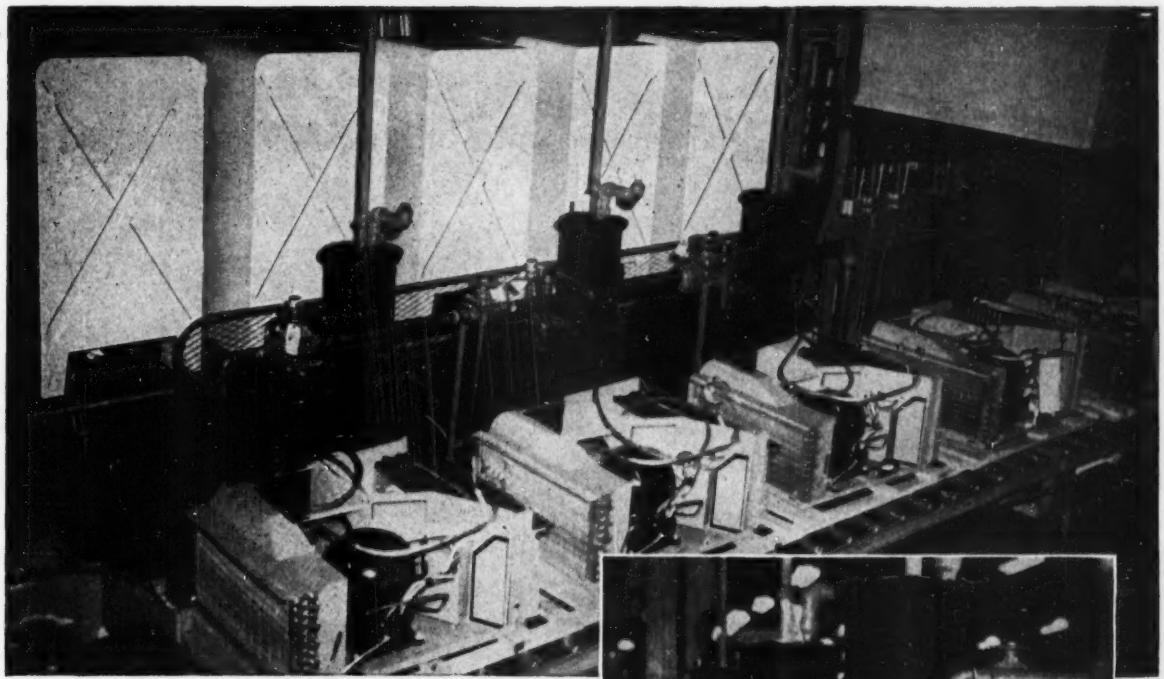
Write for Harshaw's 40-page Book on Hydrofluoric Acid Anhydrous. It provides helpful data for you if you now use HF or are considering its use.

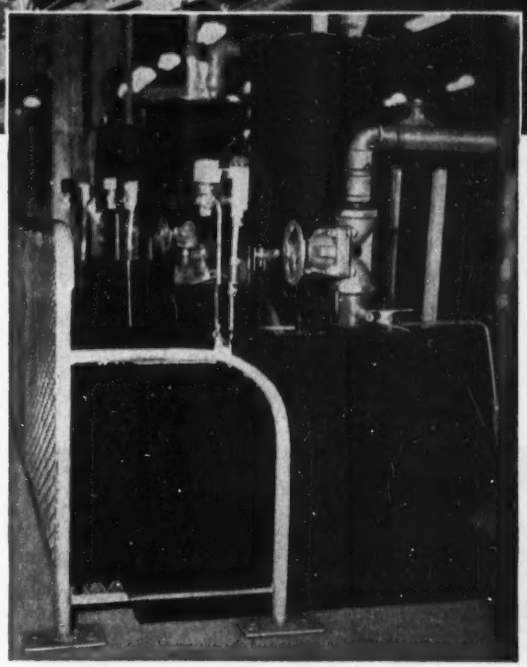


THE

HARSHAW CHEMICAL COMPANY

CLEVELAND 6, OHIO • BRANCHES IN PRINCIPAL CITIES





FAST VACUUM speeds production at Amana

Amana Refrigeration, Inc., manufacturer of air conditioning and refrigeration units at Amana, Iowa, keeps production rolling with Kinney High Vacuum Pumps. During their many years of service at Amana, Kinney Pumps have fully demonstrated their reliability, ease of operation, and economy of maintenance. Here, as in hundreds of major vacuum processing systems throughout the country, Kinney Pumps create low absolute pressures fast and efficiently, and provide quick recovery speed for high production rates.

Whatever your vacuum problem — whether for laboratory, pilot plant, or full scale production — there's a Kinney Pump to fill your needs. Kinney district offices are staffed with competent vacuum engineers, ready to help you get the right vacuum pump for each application.

Send Coupon for Complete Details

Kinney

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☐ Please send Bulletin V54 describing the complete line of Kinney Vacuum Pumps.

☐ Our vacuum problem involves .....

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Company .....

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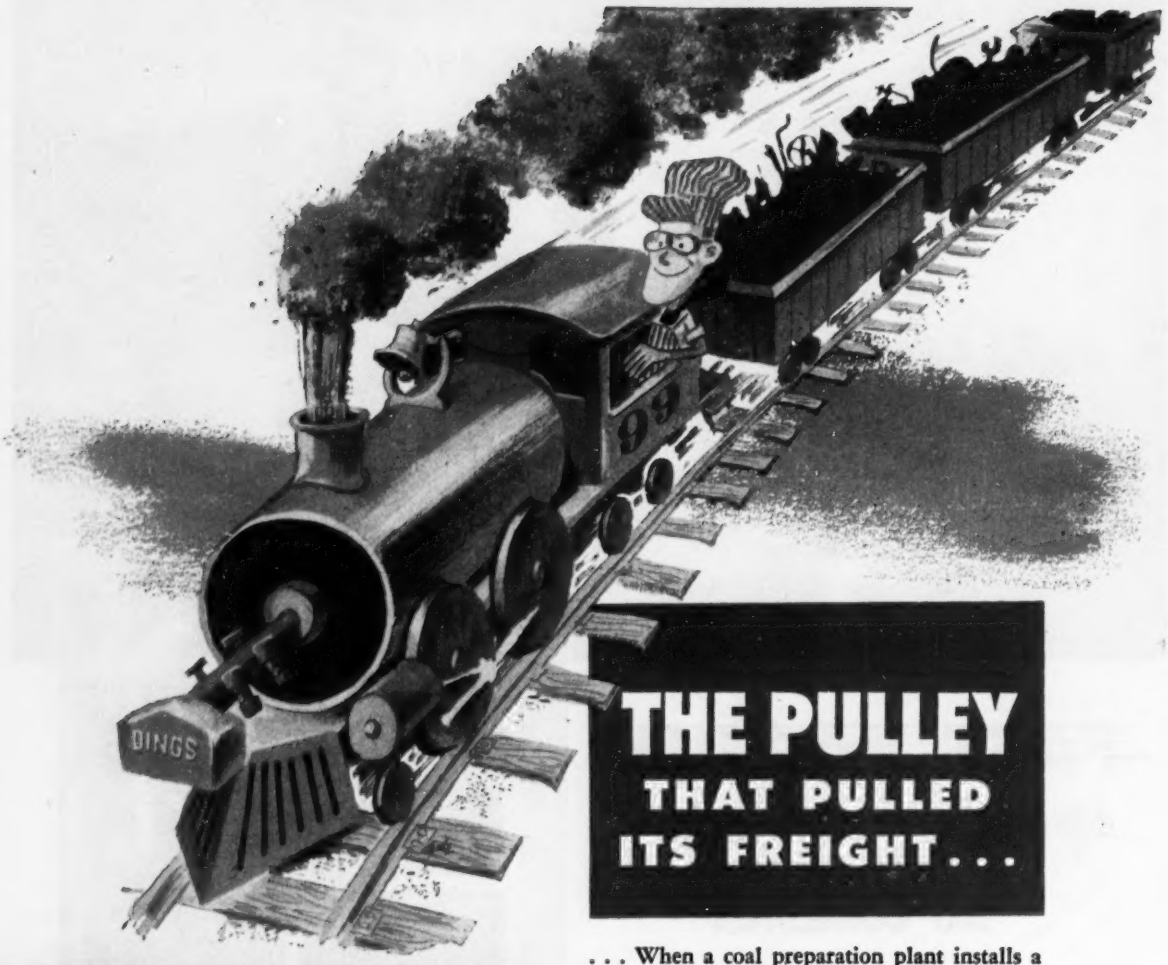
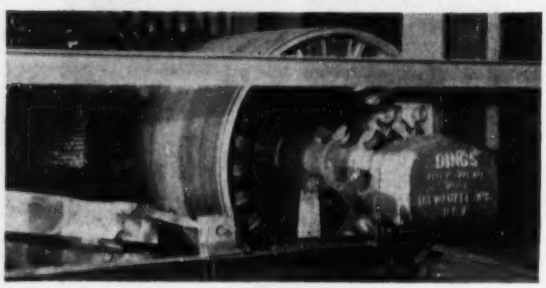


THE PULLEY THAT PULLED ITS FREIGHT...



This is the pulley that pulled its freight—amortized itself in 10 years while giving its owner an annual profit of more than $3.00 by salvaging its costs plus in scrap iron.

. . . When a coal preparation plant installs a magnetic pulley to protect equipment against bolts, spikes, cutter bits and other stray iron, the pulley is expected to cost something. But, a West Virginia producer found that his Dings Magnetic Pulley recovered scrap iron and tools of sufficient value (about $243 a year) to pay maintenance, power and depreciation costs ($239.64)—and show an annual cash profit of more than $3.00! Now the Dings pulley is still operating long after being amortized, and it's still bringing in that high annual return in scrap.

What is your tramp iron problem? Dings can solve it profitably. *Ask for Bulletin C-5000-B.*

Dings

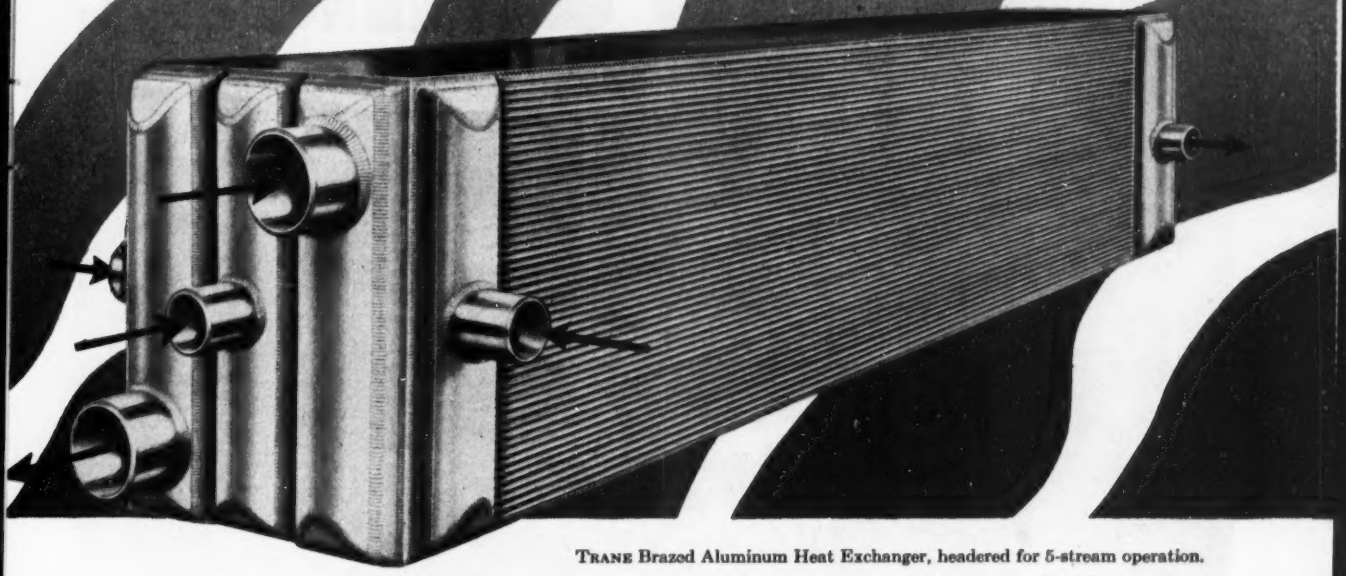
ELECTRIC AND NON-ELECTRIC MAGNETS FOR EVERY JOB

DINGS MAGNETIC SEPARATOR CO. • **4730 W. Electric Ave., Milwaukee 46, Wisconsin**

Magnetic Separation Leader for over Fifty Years

5 passes...5 gases...

with just one Trane heat exchanger



TRANE Brazed Aluminum Heat Exchanger, headered for 5-stream operation.

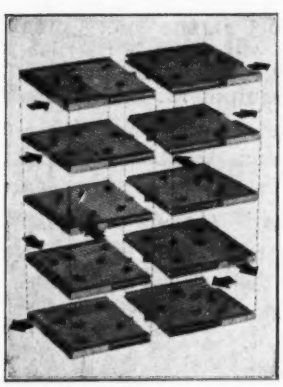
Multi-fluid heat exchanger for large scale process heat transfer saves space, saves cost

The problem of heat transfer between three, four, five or more liquids or gases in process operation can be solved by lighter, more compact, more economical TRANE Brazed Aluminum Heat Exchangers. One multiple-stream TRANE unit has in many instances occupied ⅓ the space at ¼ the weight of conventional heat exchangers, at far less cost . . . making it particularly well suited for processes using multi-stream heat transfer, such as air separation, helium and ethylene recovery. The reason . . .

More efficient heat exchange surface of TRANE brazed aluminum gives you a lighter weight heat exchanger that packs up to 450 sq. ft. of heat transfer surface into one cubic foot, yet operates at pressures up to 500 psig with temperatures as low as —350° F.

Whether your heat exchange problem involves close temperature approach, low temperatures or multi-fluid heat transfer, there is a TRANE Brazed Aluminum Heat Exchanger to fit your needs. Our 30 years' experience in all phases of heat transfer plus our laboratory facilities provide the solution to these problems.

For further information, ask your TRANE Sales Office for a copy of "Extended Surface Heat Transfer Equipment" or write TRANE, La Crosse, Wisconsin.



This symbolic drawing shows how one TRANE Brazed Aluminum Heat Exchanger can handle as many as five fluids simultaneously. Compact design simplifies headering. Units are available for cross-flow and counter-flow operation.

TRANE *brazed aluminum heat transfer surfaces*

MANUFACTURING ENGINEERS OF AIR CONDITIONING, HEATING, VENTILATING AND HEAT TRANSFER EQUIPMENT

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One-Cote Cement

INSULATES PROTECTS FINISHES

in one quick application

ONE APPLICATION saves valuable man-hours! Whether equipment is hot or cold (above 32 F), your crew simply trowels on the white, clean-handling cement to get a smooth, light-reflectent insulating surface.

ONE APPLICATION assures high thermal efficiency at temperatures up to 1000 F. One-Cote Cement sets quickly—and when installed indoors requires no finishing treatment. In outdoor installation, a weather-protective coating is recommended.

For a cement that INSULATES—PROTECTS—FINISHES in one application, you owe yourself a thorough investigation of Eagle-Picher One-Cote. For example, one of the many plus advantages you will value is its rust-inhibitive quality—it actually protects your valuable equipment. Get *all* the facts, today!

RECOMMENDED APPLICATIONS *Valves and fittings • storage tanks • digesters • breechings • glass and ceramic kilns • stills • ovens • steam cylinders • air preheaters • hot air ducts • turbines • piping*

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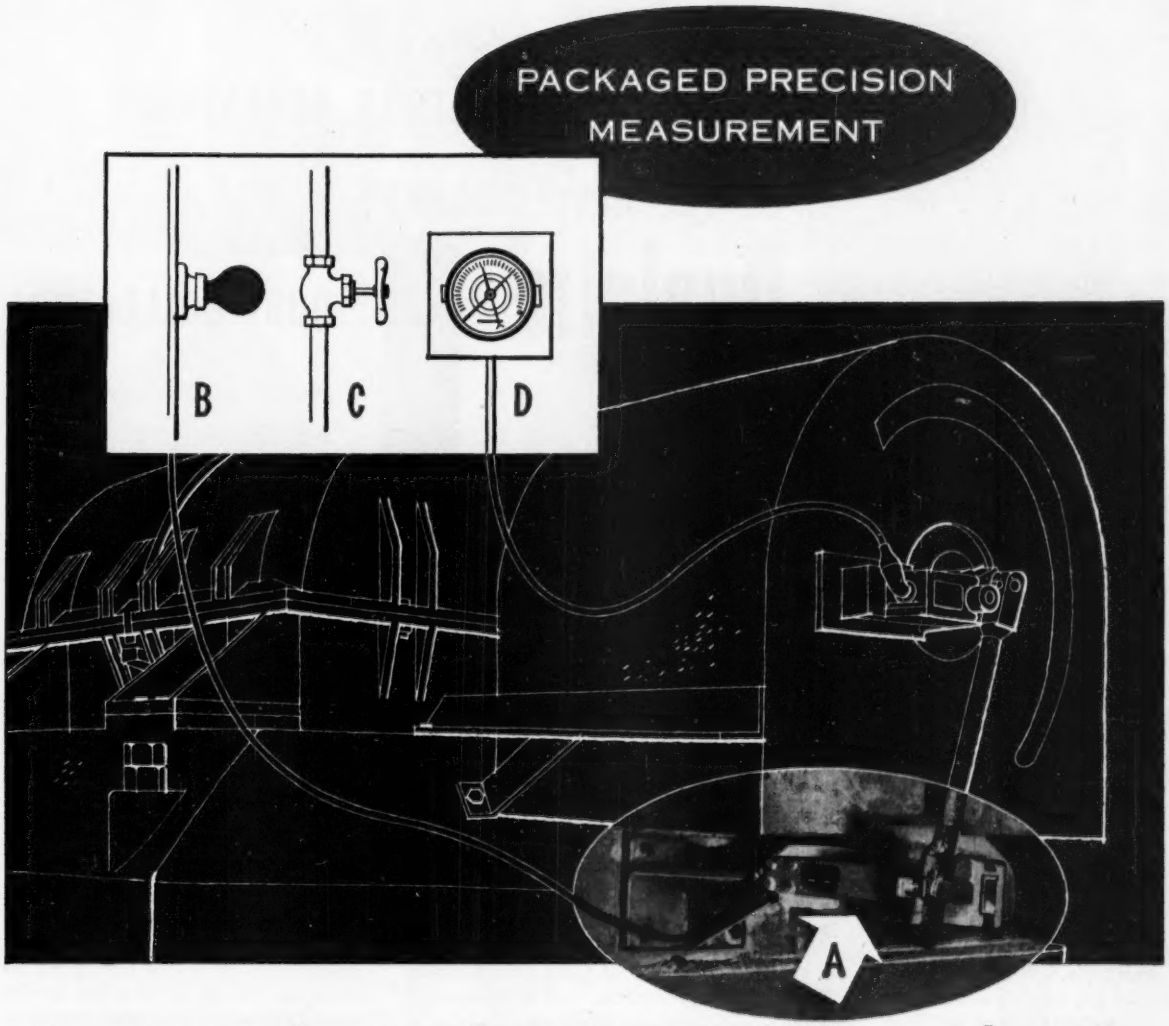
Member of Industrial Mineral Fiber Institute



Prominent plastics plant reports: "We avoid costly downtime by *automatic*, remote load control"

One of the leading plastics manufacturers reports they are getting three-way protection against downtime by using Baldwin's SR-4® Load Measuring System of simplified load control on centrifuges separating polyvinyl resin powders.

First, if the load, measured on an SR-4 Load Beam (A), exceeds a set value, the operator's attention is attracted by a signal lamp (B), and he reduces the feed rate by a hand control (C).

Second, if the load increases too quickly for manual feed reduction, the controlling electric circuit (D) shuts off the drive motor.

Third, shear pin (E) breaks to shut down drive motor only as last resort. SR-4 system virtually obviates this, avoiding downtime that would be necessary ordinarily.

This system results in almost continuous operation of the equipment at a far lower operating cost.

You can profit, too, by using a Baldwin Packaged SR-4 Measuring System to simplify operations and save you time and money . . . whatever your load, fluid pressure or torque measurement problem may be. Send now for our illustrated bulletins that will show you how. Write today to Department 3204, Baldwin-Lima-Hamilton Corporation, Philadelphia 42, Pa.

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General Offices: Philadelphia 42, Pa. • Offices in Principal Cities

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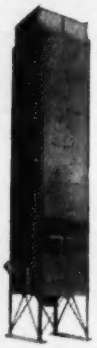
If you use filter systems...

CHECK THESE MULTIPLE ADVANTAGES OF THE REVOLUTIONARY New Dualaire* DUST COLLECTOR!



No pressure surges!
No filter choking!
Efficiencies up to 99.99%!

Why The DUALAIRE Is Better!

Here's the heart of the DUALAIRE principle. Gas enters through top of filter tube (A). Dust is filtered out along length of filter surface and as it begins to build up (B), the slight change in differential pressure causes the reverse-jet blow ring to go into operation. This ring fits tightly around the filter tube and concentrates a jet of air (C) that blows from the outside *inwardly* through the filter fabric (D).

As the ring moves up and down the tube, the fabric is flexed and blown at the same time, thus loosening the dust *in small portions*. The blow ring travels up and down the filter tube until the filter is clean, then automatically stops until the tube again requires cleaning.

Cleaning action is uniform and steady. There are no sudden pressure surges as filter surface is cleaned — no destructive rapping or jarring operations to shorten life of filter element — no wide variations in gas flow or plant efficiency!

If you use bag-houses or other similar collecting systems in your plant operations, be sure to investigate the *many* vital advantages built into Western Precipitation's new DUALAIRE Dust Collectors. Backed by the same well-known organization that pioneered commercial application of COTTRELL Electrical Precipitators and MULTICLONE Mechanical Collectors, DUALAIRES bring entirely new performance and efficiency standards to filter-type collection systems.

As outlined at the left, heart of the DUALAIRE is a reverse-jet blow ring that travels up and down the cloth filter tube, keeping it clean without the alternate choking and pressure surges characteristic of conventional rapping, vibrating, or jarring systems of cleaning off the collected dust. *Result*—

▶ **UNIFORMLY LOW PRESSURE DROP** is assured, because the collected dust is removed steadily and in small increments — not by sudden surges!

▶ **UNIFORMLY HIGH EFFICIENCIES** — as high as 99.99% under actual field conditions — are maintained by the constantly-cleaned filter surfaces. There is no "choking" action — no variation in filter efficiency as dust accumulates!

▶ **LONGER FILTER LIFE** is obtained because the filter fabric is not subjected to destructive jarring, rapping and vibration of conventional filter cleaning methods. The Dualaire cleaning action is gentle — yet far more effective!

▶ **LESS EQUIPMENT IS REQUIRED** to handle a given capacity with the Dualaire because no standby sections need be provided for gas cleaning while other sections are shut off for rapping. The Dualaire filter is kept constantly clean — automatically — while it is filtering out the suspensions. The gas is filtered and the dust removed simultaneously — without interruption. Saves space, simplifies installation!

▶ **MAXIMUM ADAPTABILITY** to varying installation requirements is assured by the "sectionalized" design of the Dualaire. Each section is available in 5 different heights — and as many sections can be bolted together as desired to meet plant requirements. As needs increase, simply add more sections!

▶ **EFFICIENT STRAIGHT-THRU DESIGN** of filter tubes assures easier dust recovery, better flow. Dirty gas enters top of tube, is filtered through the walls, and dust drops by gravity through bottom of tube into collection chamber. Separated material does not re-entrain in the gas flow

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DESIGNERS AND MANUFACTURERS OF EQUIPMENT FOR COLLECTION OF SUSPENDED MATERIALS FROM GASES & LIQUIDS

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There are many other advantages built into the DUALAIRE. *For further details send for this descriptive 12 page booklet. Or contact your nearest Western Precipitation representative!*

*"Dualaire" & "Multiclone" ®

Licensed by H. J. Hersey, Jr.

M·S·A

Safety Equipment Headquarters for the CHEMICAL INDUSTRY

ORDINARY WORK CLOTHES

M·S·A CHEMKLOS

HERE'S YOUR REAL PROOF THAT M·S·A ChemKlos LAST!

Both shirts shown above were worn by a worker handling aluminum chloride and perchlorethylene. After one week's wear, and one washing, the ordinary work shirt fell into holes, a total loss. It's a different story for the M.S.A. ChemKlos shirt. After five month's wear, and many washings, it was still in good condition, as you can see from the photo at top right.

M.S.A. ChemKlos *wear* ON when other work clothes *wear* OUT because they are made entirely of Dynel, a fabric that resists acids and caustics, and are loomed in a special weave that gives improved abrasion resistance. Washing qualities are excellent. Available in shirts, trousers, coveralls, laboratory coats and smocks for men and women. Write for details.

OTHER M·S·A PRODUCTS FOR GREATER SAFETY, PRODUCTION

- **EYE AND FACE PROTECTION**—Acid Hood, Ear Defenders, Faceshields, Plastic Hoods, Welder's Helmets, Goggles.
- **SAFETY CLOTHING**—Asbestos, Chrome Leather, Flame-Proof Duck, Plastic and Rubber Gloves, Aprons, Sleeves and Suits—Dynel Work Clothes, Safety Belts.
- **HEAD PROTECTION**—Skullgard Hats and Caps, Glass-Fiber Hats, Shockgard, Combination Skullgard-Welding Shield.
- **VENTILATION EQUIPMENT**—Air Mover, Portable Blower, Ultra-Aire-Space Filter, Welding Fume Exhauster.
- **ARTIFICIAL RESPIRATION & OXYGEN THERAPY EQUIPMENT**—Pneolator, H-H Inhalator, Pneophore, Demand Pneophore.
- **INSTRUMENTS, DUSTS**—Cascade Impactor, Electrostatic Sampler, Midget Impinger, Dust Counting Microprojector.
- **INSTRUMENTS, GAS**—Carbon Monoxide and Combustible Gas Indicators & Alarms, Explosimeter, Infra-Red Liquid and Gas Analyzer, Oxygen Indicator; Hydrocyanic, Hydrogen Sulphide, Carbon Monoxide, Sulphur Dioxide and Aromatic Hydrocarbon Detectors.
- **MASKS**—Industrial Gas Masks, "All-Service" Gas Mask, Hose Mask.
- **OXYGEN BREATHING APPARATUS**—Chemox Oxygen Breathing Apparatus, Demand Mask, Work Mask.
- **RESPIRATORS**—Mechanical Filter, Chemical Filter, Air Line.
- **FIRST AID**—All-Weather First Aid Kits and Materials, Burn Treatments, Fend Protective Hand Creams, Fire Blankets, Stretchers, Salt Tablets and Dispensers.

MSA
SAFETY EQUIPMENT HEADQUARTERS

Call the M.S.A. man on your every safety problem . . . his job is to help you

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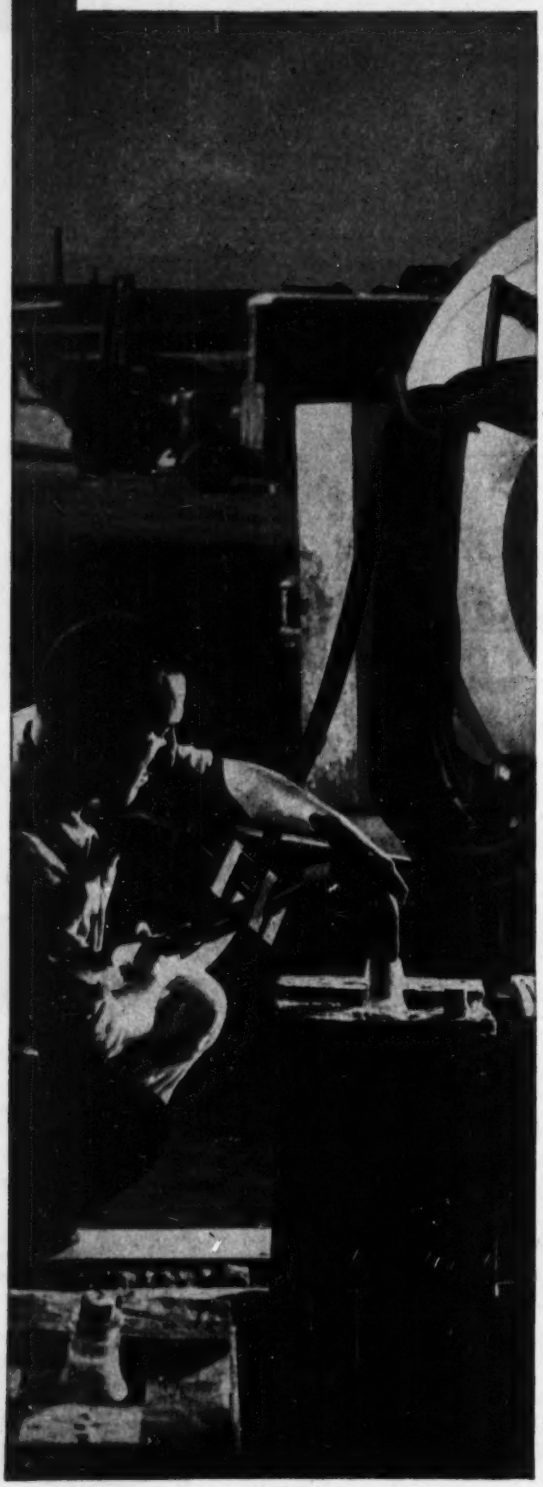
SERVING SAFETY
40 YEARS
1914 ★ 1954

Pipe Corrosive Chemicals



through

TYGON TUBING

Today's better way to conduct corrosive liquids or gases is with rugged, heavy-duty, TYGON TUBING. This flexible, plastic pipe, in sizes up to 2" ID, is used extensively as temporary or permanent acid and alkali lines; as inlet and discharge ports for chemical pumps and filters; as drainage and supply lines to and from reactors and storage tanks; and as a safe, efficient conducting medium in many other applications.

Available in six standard formulations to meet a wide range of chemicals and other operating conditions, TYGON TUBING, ranging from crystal clear to glossy black, is highly resistant to acids and alkalies, oils and greases, alcohols and water. Its minimum extractability permits use with the most sensitive solutions. Its smooth surfaces afford faster flow and quicker, easier cleaning. Its full flexibility makes even the most difficult installation simple. Its high strength, abrasion resistance, and non-aging characteristics insure long service life.

Why not solve the gas or liquid transmission problems in your plant by writing today, for detailed information and technical data on TYGON TUBING? Ask for free Bulletin T-87. Address: U. S. STONEWARE, AKRON 9, OHIO.

Plastics and Synthetics Division

U. S. STONEWARE

AKRON 9, OHIO

421-D

SEPTEMBER
1954

Chementator

Edward T. Thompson

• With government backing, a non-electrolytic process for battery-active MnO_2 developed by E. S. Nossen Laboratories has reached the 1,000 lb. per hr. pilot plant stage. It uses nitric acid leaching and air oxidation of low-grade Maine ores to slash investment costs.

• National Distillers, by selling its insecticide plant at Fairfield, Md., to Food Machinery Corp. has now completely rid itself of all resin, antifreeze and insecticide operations acquired when it bought U. S. Industrial Chemicals, Inc., in 1951.

Sulfur by distillation

Elemental sulfur, distilled directly from pyrites, will soon be coming from a new Canadian plant. Product is slated for north-of-the-border pulp makers and other sulfur users.

Due to start initial operations this month, Noranda Mines, Ltd., at Welland, Ont., will sinter pyrites in two countercurrent stages using a process originally worked out at Battelle Memorial Institute. Noranda worked with the National Research Council of Canada to commercialize the method.

The first stage is deficient in oxygen, so part of the sulfur is distilled without oxidation. In the second stage, the rest of the sulfur is converted to sulfur dioxide. This will be piped as a dilute gas to the adjacent plant of North American Cyanamid for conversion to sulfuric acid.

Expected daily output, based on a charge rate of 370 tons of pyrites, will be 62 tons of sulfur, 240 tons of SO_2 and 252 tons of iron oxide sinter, the last for steel mills in the area.

Sweeping changes set for Bureau of Mines

No longer will shale oil research play a predominant role in Bureau of Mines activity. Instead, the emphasis is going to be on improving recovery of known oil reserves, an area neglected by the bureau in recent years. Statistical services to industry will also be improved.

Two projects in particular are scheduled for severe curtailment. At Rifle, Colo., oil shale experimental work will cease unless there is a "substantial contribution" by industry under a cooperative agreement. And at Morgantown, W. Va., and Bruceton, Pa., research on synthetic fuels from coal and lignite will be confined to small-scale activity. There will be no expansion into large pilot or demonstration plants. In addition, the number of bureau regional offices will be cut from nine to four.

These rather drastic policy reversals are based on the report of a five-man survey team that reviewed the agency's efficiency early this year. The report stressed, in part, that "the petroleum and natural gas work of the bureau should regain a position of leadership in the field of research and thus play a more important part in solving the problem of future liquid fuel supplies from any source."

Biological process treats pulp mill waste

West Virginia Pulp and Paper has just started building the largest waste treatment plant in the pulp and paper industry—at Covington, Va. It is the industry's first attempt to commercialize the activated sludge process developed by W. A. Moggio at Louisiana State University and pilot-planted at Covington.

Key to the process was the discovery that only nitrogen and phosphorus are needed in mill wastes to give a diet on which activated sludge organisms can subsist. Addition of 365 lb. of nitrogen (as 35% aqueous ammonia) and 95 lb. of phosphorus (as 75% phosphoric acid) to 16 million gallons of

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waste flow daily at Covington will reduce the Biochemical Oxygen Demand (BOD) from 140 to 15 ppm. About 8 million gallons of the mill's waste are low in BOD and don't need this treatment.

Feed to the $2 million plant will be in two streams, one from the first two bleaching stages, the other from pulping operations. The latter, because it's high in solids, goes through a primary settling (2 hours), then the streams are mixed.

Activated sludge, with makeup ammonia and acid, are added in a baffle mixing chamber and the flow is split for final treatment—aeration (3 hours) and settling (2½ hours)—in two parallel units. These are based on the Dorr Co. Currie design—a circular secondary settler surrounded by an annular shaped aeration chamber.

Recovered active sludge is returned to the mixing chamber, with all excess retained for 24 hours in a storage tank where its own BOD is reduced. This excess is then pumped to the primary settler and combines with settled solids from the pulping waste. The mixture, which has little biological activity, goes finally to a large fly ash settling basin.

Total residence time in the system, excluding fly ash settling, is 31¼ hours. Operation is completely automatic and requires only one operator and a part-time laboratory man per shift.

All is not serene in rubber plant sale

Although the total number of bids entered is impressive—56 first line, 19 alternates—right now it looks like the sale of government-owned rubber plants to private industry may have hit a snag—lack of competition.

According to unofficial breakdowns of the bids received, only five of the 27 plants for sale attracted more than one bid. And three weren't bid on at all, including the large GR-S plant at Institute, W. Va., notorious for its high operating costs. That leaves 19 plants that drew only one bid apiece.

Actually, the situation doesn't surprise too many people. Apathy has been growing since last winter and there was little the government could do to counteract it. Everybody, it seems, wants government out of the rubber industry, but few companies are really anxious to take over. As a top executive of one firm put it this spring: "We're going to bid on three plants. But frankly we'd like to end up with none."

That's not the kind of attitude that makes for hard bidding, but it's what the disposal commission has to contend with. Still, all is not lost and the negotiators have a couple of good bargaining tools that may change some minds.

First, not all the plants have to be sold. But if most of them are, the rest must be mothballed. Thus a company knowing it is the only bidder for a given plant might well feel forced to meet the commission's "fair price" rather than let the plant be shut down.

Secondly, the commission can recommend to Congress, which holds a veto power over all sales, that the whole sale be cancelled if not enough plants can be disposed of at a satisfactory price. With this stick over their heads, companies that lose out on their first choice might be more inclined to bid on less desirable plants of the same general type (which the law permits them to do).

On the brighter side, some of the facilities are in good demand. The 57,000-ton styrene monomer plant at Los Angeles reportedly received 11 bids. The 89,000-ton GR-S plant at Los Angeles is wanted by at least four companies. And multiple bids were received on three of the eight butadiene units—those at Lake Charles, La., Port Neches and Houston, Tex. In addition, the two butyl rubber plants, although bid on only by their present operators, Esso Standard Oil and Humble Oil, are expected to bring good prices.

And so negotiations continue: Congress dead set against a giveaway, industry not too sure it really wants the plants anyway.

Pure Oil buys more refining capacity

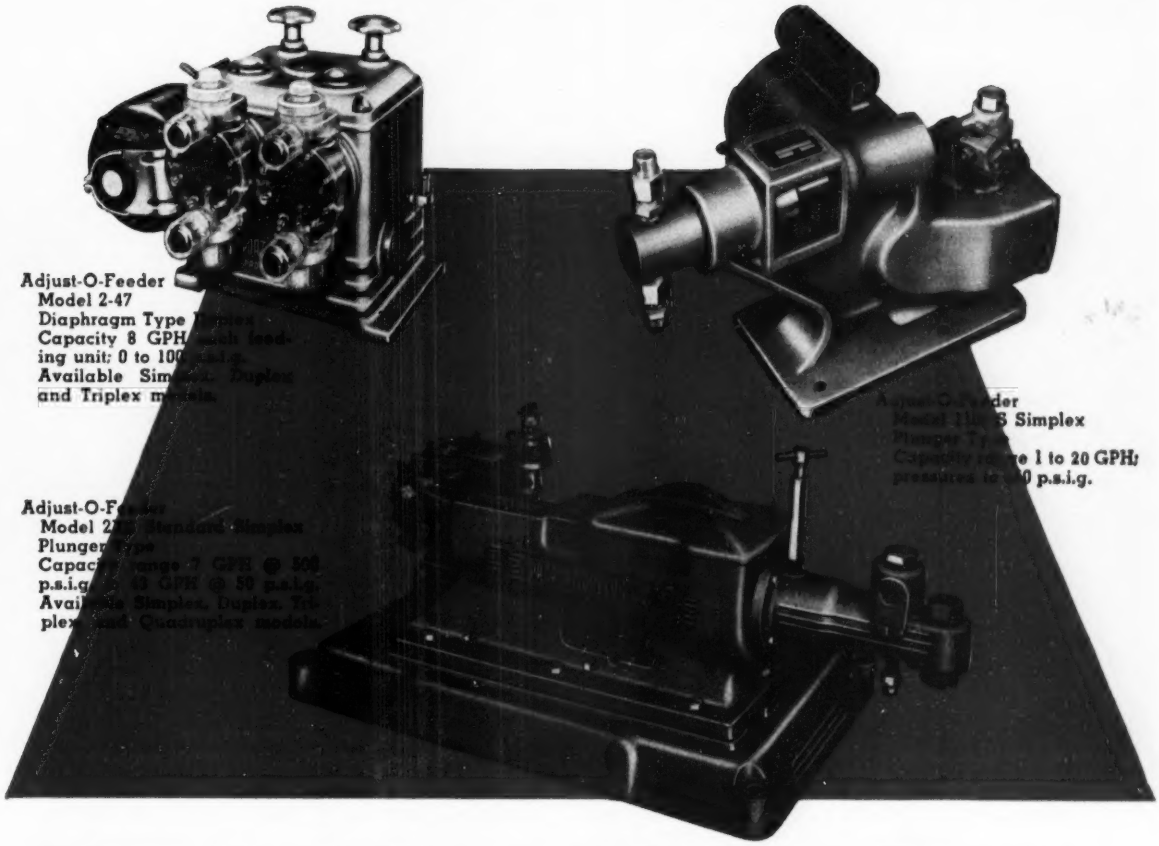
In one easy motion, Pure Oil Co., Chicago, recently upped its refining potential from 123,500 barrels a day to 170,000—by acquiring the Globe Oil and Refining Co.'s facilities at Lemont, Ill. Almost simultaneously, Pure cuts its purchases of Illinois crude oil by 20%.

The 47,500 bpd. Lemont refinery is in the midst of a major expansion. An alkylation unit was just completed there and cat cracking capacity is being doubled. Globe will continue in business as a marketer only, buying refined products from Pure.

High intensity arc—new engineering tool

Practical high temperature reaction technology may soon get an important shot in the arm from work now being done by Charles Sheer and Samuel Korman of Light Metals Refining Corp., New York. They use what's known as a high intensity arc—generates temperatures in the 15,000-20,000 F. range—to reduce compounds and refractory ores to their chemical elements by actual vaporization.

(Continued on page 110)



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These versatile pumps are complete, self-contained and ready to operate. They need only electrical and piping connections to go to work. Most requirements for additive injection, application of treating chemicals, filling and dispensing, as well as sampling in chemical processing, are readily met by Adjust-O-Feeder proportioning pumps. Write for Bulletins. Proportioneers, Inc., 369 Harris Ave., Providence 1, Rhode Island.

ADJUST - O - FEEDERS — the economical, quick answers for chemical proportioning in process operations.

PROPORTIONEERS

DIVISION OF B-I-F INDUSTRIES, INC.

BUILDERS IRON FOUNDRY • OMEGA MACHINE CO. • BUILDERS-PROVIDENCE, INC.

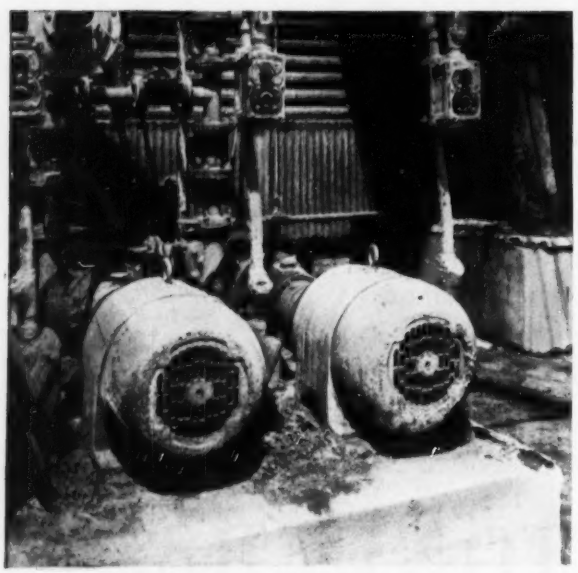
B·I·F METERS FEEDERS CONTROLS

TECHNICAL SERVICE REPRESENTATIVES IN PRINCIPAL CITIES OF THE UNITED STATES, CANADA, MEXICO AND OTHER FOREIGN COUNTRIES

ADVICE: Replace switches and fuses with compact G-E switchgear designed with adequate interrupting capacity. Place the equipment in ventilated room to combat corrosion.

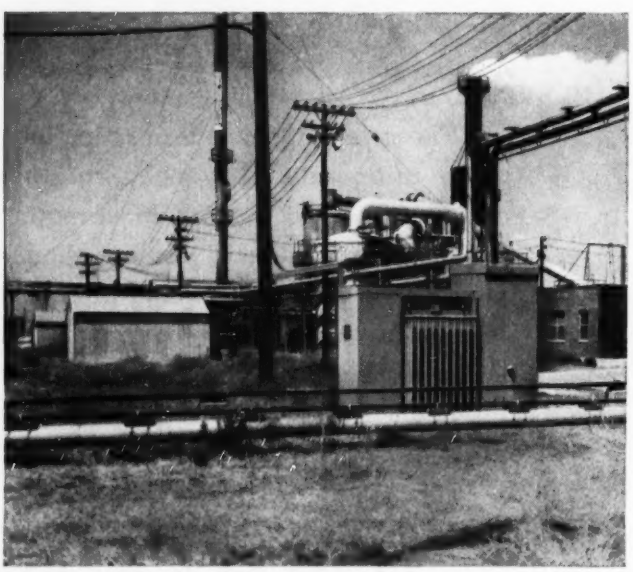
RESULT: Reliable primary power service from main substation. Corrosion problems minimized. Pre-assembly of this metal-clad switchgear at factory cut installation time.

G.E. helps convert wartime plant

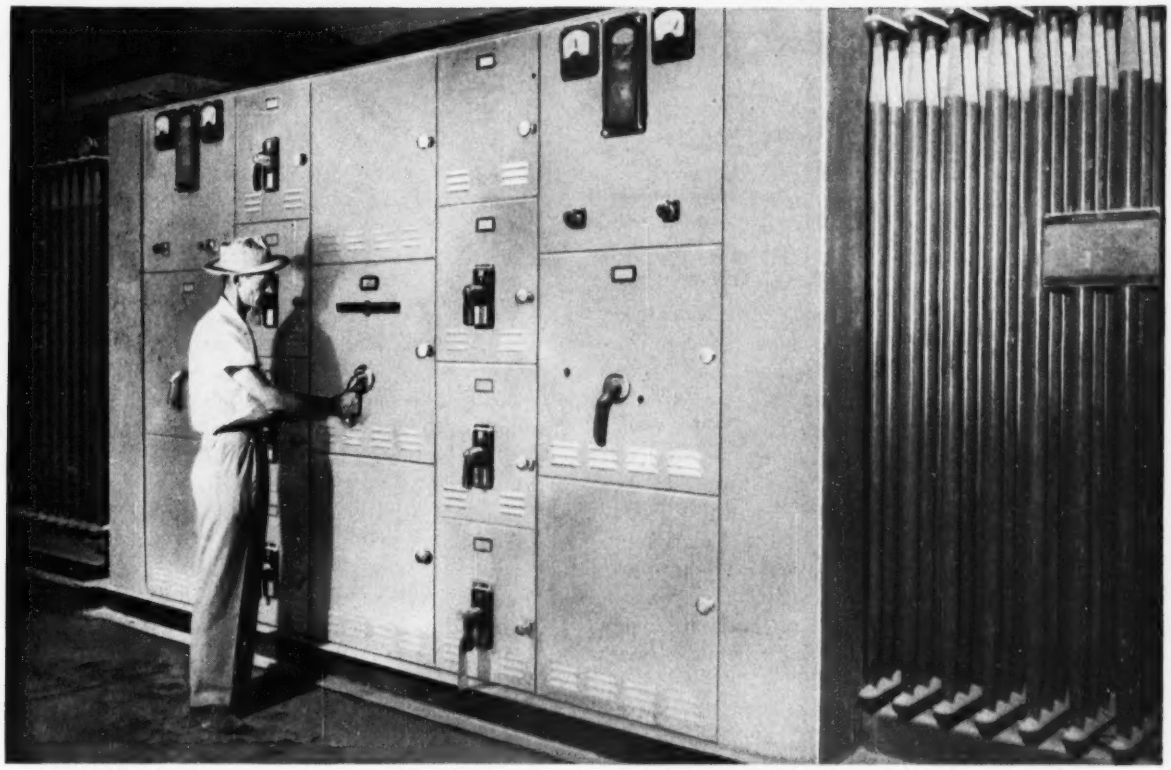


ADVICE: Replace open motors in corrosive areas with G-E totally enclosed, fan-cooled, corrosive resistant Tri-Clad* motors. **RESULT:** G-E motors, such as these driving recirculating pumps, last longer, require less maintenance.

Reg. Trade-mark of General Electric Company.



ADVICE: Place this 500-kva load-center substation near work load which is remote and in less corrosive atmosphere. **RESULT:** Reliable power supply, fewer power lines from primary station, selective fault isolation of secondary circuits.



ADVICE: Replace open pole lines for primary distribution with armored cable. Install G-E double-ended load-center unit substation in ventilated room in center of load area.

RESULT: Fewer and better protected primary lines. Selective tripping of load-center circuit breakers limits secondary power outages to faulty lines. Additional units may be added in the future.

into efficient fertilizer producer

Step-by-step installation of G-E electrical system keeps production smooth at ex-superphosphate plant

A large chemical company operates a superphosphate plant built during World War II, which has been converted to the manufacture of a high-grade fertilizer. The plant's electrical equipment needed to be replaced—and without interrupting production.

General Electric engineers—called in on the problem—made an extensive plant survey and recommended a step-by-step electrical modernization program. The program as adopted combined latest techniques and modern equipment to effectively combat the extreme corrosion caused by sulphuric acid, phosphoric dust, and other chemicals.

In succession, a compact G-E primary substation was installed in a ventilated room—vulnerable power lines were replaced with G-E armored cable—G-E unit substations were located near load centers to cut power losses—and open motors were replaced by G-E totally enclosed motors designed for chemical service. Result: the company reports complete satisfaction with the system.

Whether you plan to build, expand, or modernize a chemical plant, you too can profit by the services of G-E specialists in application and field engineering. These and other specialized engineering services are available to you through your local G-E Apparatus Sales representative. Call him early in your planning stage. General Electric Company, Schenectady 5, N. Y.

662-46

Engineered Electrical Systems for the Chemical Industry

GENERAL ELECTRIC

Applied first in big military searchlights, the high intensity arc differs radically from conventional arcs (which operate at about 6,000 F.). Current input and density are increased to a point where the anode crater covers the entire end surface. The anode material actually boils then and a high velocity (100 mph.) tail flame of highly ionized vapor shoots out of the current stream. It extends as much as two feet from the anode although electrode spacing may be only one inch.

In their experimental unit, which is primarily for the production of beryllium chloride, Sheer and Korman form anodes from a mixture of carbon and beryl ore. These are fed into the furnace continuously with a stream of chlorine. The latter quickly quenches and reacts with the ionized metals and the resulting chlorides, including iron, silicon and aluminum, are condensed successively in pure form.

Because as much as 90% of the input energy can be concentrated at the end of the anode, power needs are low—3-6 kwhr. per lb. for $BeCl_2$.

The ultimate aim of the process is to develop an effective new technique for high temperature chemical processing, conceivably extending into such fields as acetylene and nitric acid. For the present, though, the accent is on production of metal chlorides. Processes for electrolyzing these are being developed. In addition to chlorides of beryllium and other metals in beryl ore, aluminum powder (from kaolin clay), silica fumes and organo-metallics have been made experimentally.

Still another merger for Grace

Assuming approval by both groups of stockholders, W. R. Grace & Co. will soon acquire its third major chemical company in less than a year. Getting the nod this time is Dewey and Almy Chemical Co. of Cambridge, Mass., in which Grace has held a minority interest since 1952. The first two to come under the Grace wing were Thurston Chemical (Oct. 1953) and Davison Chemical (May 1954), both fertilizer producers.

Acquisition of Dewey and Almy, besides adding more than $26 million in total assets, will give Grace the facilities to diversify into the field of specialty chemicals and natural and synthetic rubber products. Grace also has a bid in on one of the government-owned rubber plants, reportedly the styrene monomer unit at Los Angeles.

Dewey and Almy sales and income have definitely been on the rise recently. For the first half of 1954, sales totaled $20 million, up nearly $3.9 million over the same period last year. Net income per share rose from 72¢ to $1.59 in the same period. The company now has 913,898 shares outstanding.

As plans stand now, Dewey and Almy stockholders will receive Grace common on a share-for-share basis. And D&A plants will continue autonomous operation, with headquarters at Cambridge.

Monsanto to increase stake in phosphates

Already the world's largest producer of elemental phosphorus, Monsanto Chemical is taking no chances on being left behind in the phosphorus chemicals market. Latest moves involve one completely new plant and expansion of five others.

The new installation will be located at Kearny, N. J., and will turn out phosphoric acid and sodium tripolyphosphate. Reasons given for picking this site are ready availability of deep water transportation and excellent cooperation from the Pennsylvania Railroad which runs close-by.

Biggest part of the expansion of existing plants will be at St. Louis, where a new tetrasodium pyrophosphate unit will be built and sodium tripolyphosphate facilities are scheduled for an increase. At Trenton, Mich., Monsanto will up production of phosphoric acid. A new acid burner will also be installed at Monsanto, Ill. And to increase raw material supplies, the company expects to double elemental phosphorus output at Soda Springs, Idaho, by completing a second electric furnace there this fall.

Ion exchange hits its stride in sugar

Long in development and often plagued by difficulties, use of ion exchange resins to purify and decolorize sugar has now reached smooth commercial operation. Layton Sugar Co. says it is getting consistently high yields and purity at extremely low cost from its Layton, Utah, refinery. What's more, the process works equally well to make either cane or beet granulated sugars.

Layton's first full-scale operations using ion exchange were on beet sugar in 1947. But it took seven years to perfect the technique and raise capacity to its present level—400 tons of melt daily. Now, with success at hand, other sugar makers who previously were unsuccessful with ion exchange are expected to get on the bandwagon, particularly those with plants designed for combined beet-cane output.

In cane processing, the only essential change Layton makes is the use of resins to replace conventional bone char for decolorizing. On the basis of

(Continued on page 112)

Which of these Fluorine Compounds do you need?

☑ for process uses ☑ for research

FLUORINE
Elemental Fluorine

ACIDS
Fluoboric Acid
Fluosulfonic Acid
Hydrofluoric Acid, Anhyd.
Hydrofluoric Acid, Anhyd. High Purity
Hydrofluoric Acid, Aqueous Tech.
Hydrofluoric Acid, Aqueous, Purif. & Reag.

ACID FLUORIDES
Ammonium Bifluoride
Potassium Bifluoride
Sodium Bifluoride

ALKALI FLUOBORATES
Ammonium Fluoborate
Potassium Fluoborate
Sodium Fluoborate

ALKALI FLUORIDES
Ammonium Fluoride
Potassium Fluoride, Cryst. & Anhyd.
Sodium Fluoride, Tech.
Sodium Fluoride, Reagent

DOUBLE FLUORIDES
Chromium Potassium Fluoride
Potassium Ferric Fluoride
Potassium Titanium Fluoride
Potassium Zirconium Fluoride
Sodium Zirconium Fluoride
Sodium Silico Fluoride
Potassium Aluminum Fluoride

METAL FLUORIDES
Aluminum Fluoride
Aluminum Fluoride, Crystal
Antimony Trifluoride
Antimony Pentafluoride
Barium Fluoride
Cadmium Fluoride
Calcium Fluoride
Chromium Trifluoride
Cupric Fluoride
Ferric Fluoride
Lead Tetrafluoride
Magnesium Fluoride (Not Optical Grade)
Mercuric Fluoride
Manganese Trifluoride
Molybdenum Hexafluoride
Nickelous Fluoride
Selenium Hexafluoride
Silver Difluoride
Strontium Fluoride
Titanium Tetrafluoride
Tellurium Hexafluoride
Tungsten Hexafluoride
Zinc Fluoride
Zirconium Tetrafluoride

NON-METALLIC FLUORIDES
Boron Fluoride Gas
Boron Fluoride Ether (Diethyl) Complex
Boron Fluoride Phenol Complex
Boron Fluoride Ammonia Complex
Boron Fluoride Diacetic Acid Complex
Boron Fluoride Di-n-Butyl Ether Complex
Boron Fluoride Dihydrate
Boron Fluoride Piperidine Complex
Boron Fluoride Ethyl "Cellosolve" Complex
Boron Fluoride Hexamethylene-tetramine Complex
Boron Fluoride Monoacetic Acid Complex
Boron Fluoride Para-cresol Complex
Boron Fluoride Triethanolamine Complex
Boron Fluoride Urea Complex
Sulfur Hexafluoride

METAL FLUOBORATE SOLUTIONS
Cadmium Fluoborate
Chromium Fluoborate
Cobalt Fluoborate
Copper Fluoborate
Ferrous (Iron) Fluoborate
Indium Fluoborate
Lead Fluoborate
Nickel Fluoborate
Silver Fluoborate
Stannous (Tin) Fluoborate
Zinc Fluoborate

HALOGEN FLUORIDES
Bromine Trifluoride
Bromine Pentafluoride
Chlorine Trifluoride
Iodine Pentafluoride

GENETRON® ORGANIC FLUORINE COMPOUNDS

Fluoromethanes	
Trichloromonofluoromethane	CCl_3F
Dichlorodifluoromethane	CCl_2F_2
Monochlorodifluoromethane	$CHClF_2$
Trifluoromethane (Fluoroform)	CHF_3
Monochlorotrifluoromethane	$CClF_3$
Fluoroethanes	
Difluoroethane (Ethylidene fluoride)	$CH_3 \cdot CHF_2$
Difluoromonochloroethane	$CH_3 \cdot CClF_2$
Tetrachlorodifluoroethane	$CCl_3 \cdot CClF_2$
Monochlorotrifluoroethane	$CH_2Cl \cdot CF_3$
Trichlorotrifluoroethanes	$CCl_2F \cdot CClF_2$ $CCl_3 \cdot CF_3$
Dichlorotetrafluoroethanes	$CClF_2 \cdot CClF_2$ $CCl_2F \cdot CF_3$
Monochloropentafluoroethane	$CClF_2 \cdot CF_3$
Fluoroethylenes	
Difluoroethylene (Vinylidene fluoride)	$CH_2 = CF_2$
Dichlorodifluoroethylene	$CCl_2 = CF_2$
Trifluorochloroethylene	$CClF = CF_2$
Monochlorodifluoroethylene	$CHCl = CF_2$
Fluorobromoethanes	
Dibromodifluoroethane	$CH_2Br \cdot CBrF_2$
Fluorinated Acetic Acids and Anhydrides	
Dichloromonofluoroacetic acid and anhydride	CCl_2FCOOH and $(CCl_2FCO)_2O$
Monochlorodifluoroacetic acid and anhydride	$CClF_2COOH$ and $(CClF_2CO)_2O$
Fluorinated Acetones	
Tetrachlorodifluoroacetone	$CCl_2F \cdot CO \cdot CCl_2F$
Trichlorotrifluoroacetone	$CCl_2F \cdot CO \cdot CClF_2$
Dichlorotetrafluoroacetone	$CClF_2 \cdot CO \cdot CClF_2$

Various Other Organic Fluorine Chemicals

Through aggressive research and development, General Chemical sets the pace in fluorine chemistry . . . making more and more of these versatile chemical "tools" available so that your development program today can become tomorrow's production.

Listed here are a hundred organic and inorganic fluorine compounds which General presently offers. Many are produced in carload, tank car or other commercial quantities. Others are made in pilot plants or intermittently on a laboratory scale for experimental uses. For some of these, studies of properties are in early stages. General has a number of other fluorine products under investigation in addition to those on the list; thus the company is geared to serve you well—now—and in the future.

That's why it's wise to see General Chemical when your work indicates the need for fluorine chemicals. With fifty year's experience in the field, we may be able to save you time, money and effort.

First in Fluorides

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Allied Chemical

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☐ Please send me more information on_____
☐ Have a representative call on me_____
☐ I am interested in using this product for_____
Name_____
Title_____
Company_____
Address_____
City_____ Zone____ State_____ CE-9

2,500 cu. ft. of Dow MX cation and 1,700 cu. ft. of Chemical Process A-2 anion resins per thousand tons of melt per day, decolorizing costs about 2½¢ per 100 lb. bag. This compares with bone char costs as high as 7¢ a bag in many plants. Equally important, investment costs in ion exchange facilities are estimated to be only one-tenth those for bone char towers, excluding the cost of the char.

When making beet sugar most producers bleach organic impurities with sulfur fumes at a pH of about 8.0, then evaporate, filter and crystallize (in three stages). Layton, however, cools the liquor and sends it to a cation exchanger, where at a pH of 1.5-2.5 non-sugar salts are converted to acids. A pass through the anion exchanger adsorbs the acids and color bodies.

Filtration, evaporation and six-stage crystallization follow, yielding 25-32 lb. more sugar per ton of beets than conventional processes—normally about 280 lb. with top-grade beets. Layton also claims considerably higher product purity.

And resin costs are low. In over six years of operations on both beet and cane sugar, Layton has added only 5% resin makeup, still has about 90% of its original effective resin capacity.

End nears for alien property squabble

Huge General Aniline and Film Corp., seized from the Germans by the U. S. government during the war, probably will be sold to American citizens within two years. A bill sponsored by Sen. Everett Dirksen (R-Ill.), which would have required the sale, made real progress in Congress before it adjourned last month. And similar legislation has an excellent chance of passage in the next session.

The proposed law would give the German chemical industry, already pushing U. S. chemical exporters, a handsome windfall from American taxpayers.

Main purpose is to restore seized alien property worth about $500 million to its former owners—mostly German—in cash or in kind. About $200 million of enemy assets already sold by our government to compensate private American war claims will have to be made up by special appropriation.

GAF, which earned a $3 million profit for the government last year, almost certainly won't be returned physically to its former owners. A special clause in the Dirksen bill authorizes the President to require sale of former enemy property to U. S. citizens if he considers it in the national interest to keep the facilities in this country. This was expressly designed to keep GAF out of foreign hands.

Another former German chemical firm affected by the proposed legislation is Schering Corp., which makes pharmaceuticals. The company had a book value of $1.3 million when seized, but was sold in 1952 to its American stockholders for $30.8 million. The parent company, Schering A. G., would be paid at the latter figure and also probably would recover some of its seized patents.

Since the German and American companies compete, this is rather a sore point with Francis G. Brown, president of the American group. He recently complained to Congress that the proposal amounts to giving the former owners a war bonus.

Big new market for carbon black?

Soil conditioners, that always enticing, sometimes disastrous field, may soon have a new entry—carbon black. The potential, if the idea catches on, exceeds even the carbon black tonnages now consumed by the rubber industry.

Use of carbon black as an aid to agriculture has been under study for some time by a number of companies. But because of the price structure, there's been little interest or success. Now, however, the Lynn Furmatic process (*Chem. Eng.*, July 1953, p. 120), which claims to make a 50% cheaper carbon black, looks like it's going commercial. Further tests and process improvements are said to substantiate early claims and Consolidated Carbon of Chicago says it will build 10 full-scale plants soon.

Cheap black, say Chicagoans J. T. Plunkett, E. W. Hebestreet and J. F. T. Berliner, is the key to use as a soil conditioner.

Carbon black, bulk material, a binder and a dispersing agent are mixed, aerated and extruded as a spaghetti-like material. This would be drilled into the soil with conventional equipment. Sun and water break it down to a humus-like dispersion that conditions the soil by holding moisture and warming it through retention of the sun's heat.

Bulk material can be organic, inorganic, fibrous or tuberous matter. Most important is that it be available in bulk at low cost, presumably a waste material. On an experimental basis, sewage sludge, calcium sulfate and vegetable wastes have been used successfully.

If sewage sludge is the bulk it contributes some nitrogen, phosphorus and valuable trace elements. Eventually the developers expect to be able to mix in commercial fertilizer to give the product a double wallop.

For more of WHAT'S HAPPENING . . page 114

Mathieson Chlorine: *worth its salt*

Row upon row of mercury cells characterize the uniform high purity of Mathieson chlorine. These cells decompose a salt solution by electrolysis to form a sodium amalgam and wet chlorine gas. Subsequent processes dry the gas, liquefy and cool it, resulting in chlorine approximately 99.9% pure. Above is one of five producing units from which Mathieson supplies quality chlorine to industries from Canada to the Gulf.

Consistent product quality is typical of all Mathieson chemicals. In addition, Mathieson offers consumers the protection of multi-plant production facilities . . . 3 major alkali plants, 7 sulphuric acid plants, 6 caustic soda plants, 3 ammonia plants . . . as well as practical technical assistance with chemical handling and application problems.

In planning your chemical requirements call in your Mathieson representative. Perhaps you can buy to better advantage from one of America's largest producers of basic industrial chemicals.

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INDUSTRIAL CHEMICALS DIVISION

BALTIMORE 3, MARYLAND

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ETHYLENE OXIDE • ETHYLENE GLYCOL • DIETHYLENE GLYCOL • TRIETHYLENE GLYCOL • POLYGLYCOLS • DICHLOROETHYLETHER • ETHYLENE DICHLORIDE • METHANOL • SODIUM METHYLATE • ETHYLENE DIAMINE 2622

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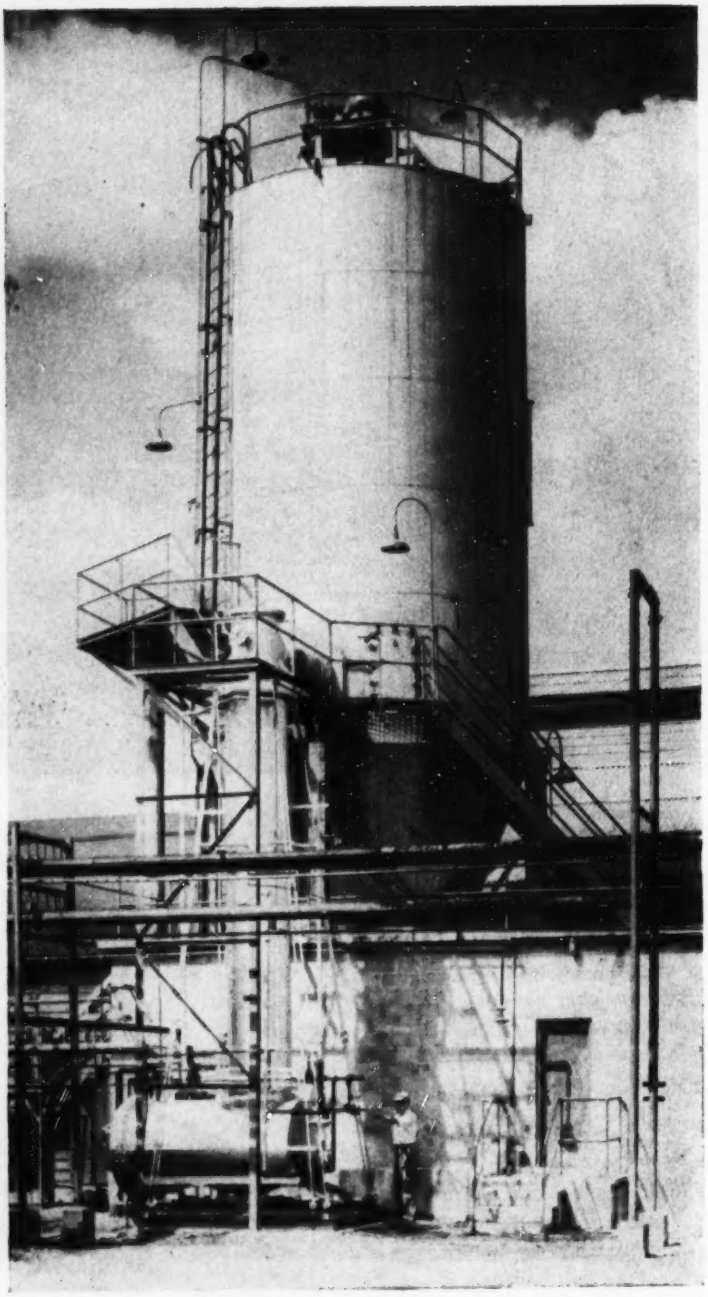
New Anhydrous Ammonia Source: Coke Oven Gas

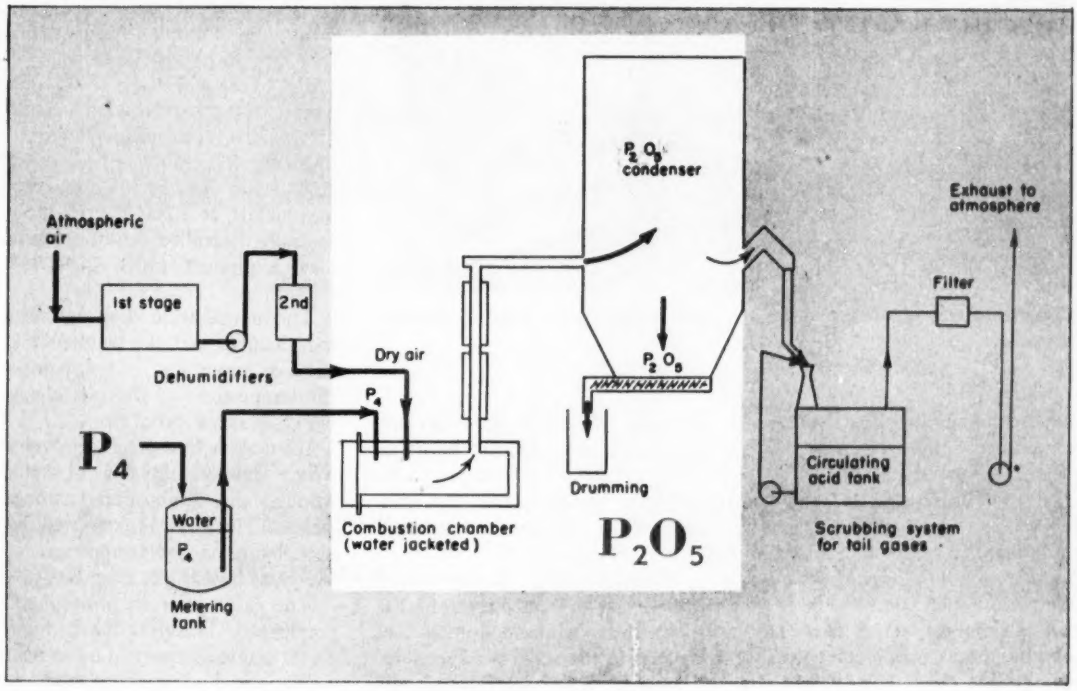
Watch for a new entry in the anhydrous ammonia market—U. S. Steel Corp. The company is now well-advanced in a study aimed at finding the most economical method of recovering hydrogen from coke oven gas. If successful, it will start making anhydrous ammonia at its Gary, Ind., and Geneva, Utah, by-product coke plants. Nitrogen would presumably be obtained by air liquefaction.

For a number of years many coke oven operators have recovered such products as benzene, toluene and pyridine, then passed the gas through sulfuric acid to produce ammonium sulfate. This practice will be continued at Gary and Geneva.

But after stripping the gas, U. S. Steel, for the first time, plans to remove hydrogen. One likely way is to compress the gas, condensing out all gases except hydrogen. At the same time it would be possible to scrub out various other desired gases.



PHOSPHORIC ANHYDRIDE—a new unit to meet new and rising demands.→



Process for Making Phosphoric Anhydride

In new unit, Virginia-Carolina makes this important chemical. Key factors in the smooth running process: drying of air feed; exact control of feed ratios.

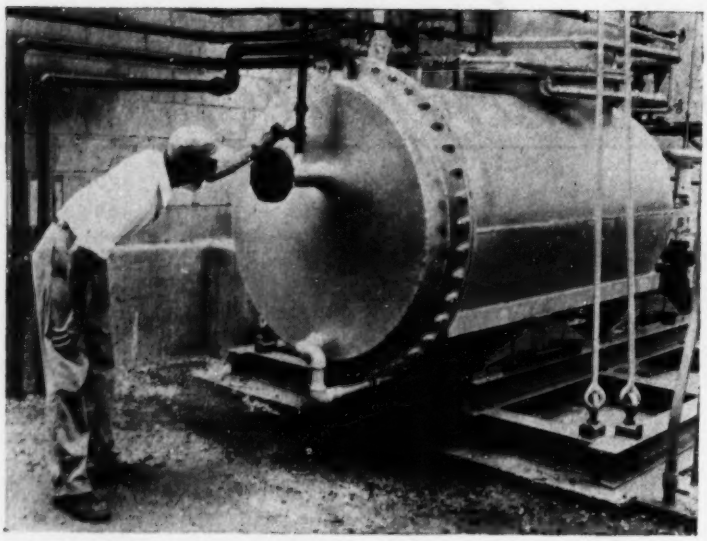
Phosphoric anhydride—P_2O_5—is better known as a short-lived intermediate in the manufacture of phosphoric acid from elemental phosphorus than as a commercial chemical in its own right.

But recent developments are beginning to focus more attention on the anhydride. Among them is the startup of a new anhydride manufacturing unit at Virginia-Carolina's Charleston, S. C., plant.

Production is aimed at meeting a steadily rising demand from plastic, chemical and asphalt manufacturers. One promising market—as a catalyst in the production of water-resistant paving asphalts. Other uses in order of tonnages—condensation and polymerizing agent; production of organic esters; production of polyphosphoric acids; as a drying agent; and miscellaneous uses. V-C sees a total potential U. S. yearly demand of over 20,000 tons before 1960.

Basically, the process used at Charleston is simply the burning of molten phosphorus in dry air. The unit consists of an air feed system, a phosphorus feed system, a combustion chamber and a condensing chamber. But each section has important process and equipment features:

• Air feed. A blower passes air through a two-stage activated alu-



COMBUSTION of phosphorous takes place in this water jacketed chamber.

mina dehumidifier. Reactivation of the alumina in the first stage takes place continuously.

• Phosphorus feed. Molten phosphorus is displaced from a feed tank by a metered stream of hot water. Phosphorus itself is not metered or pumped.

• Combustion. A fixed ratio of phosphorus to air going to the combustion chamber is maintained to get a pure P_2O_5. This is done automatically by an air operated ratio controller.

• Condenser. Solid P_2O_5 comes out in a 40-ft. high condenser. It's wiped off the sides of the "barn" by chains hanging along the full height.

▶ **Critical Step**—Certainly one of the most important steps in the process is drying of the combustion air. If there is too much moisture in the air going to the phosphorus burner, polymers form, and serious corrosion develops. By wringing the air practically bone dry (0.0011 lb. water in 1,000 cu. ft. air) V-C successfully uses mild steel up to the exit gas recovery system.

Dehumidification is carried out in dryers packed with activated alumina. A two-stage arrangement, the first stage involves continuous reactivation of the alumina.

This first stage dryer is divided into four horizontal, stationary sections—each section having an upper and lower bed of alumina, with an air space between beds. An end-view shows the sections arranged around a central shaft.

A rotary valve directs steam-heated air for reactivation to the spent beds; while delivering wet air feed to the reactivated sections. Flow of air is through the beds and out the air space.

Beds are continuously cut out of service onto reactivation, then back to service. Air coming out of the first stage has a dew point of −5 F.

The second stage has two absorbers which are used alternately and reactivated in a batch operation. Air comes out of the second stage with a dew point of -70 F. It's metered with a rotameter.

▶ **How to Feed Phosphorus**—A feed tank holds the molten phosphorus—which comes from an adjacent V-C arc furnace. Hot water is metered (rotameter) into the tank, displacing the phosphorus into the combustion chamber.

Instrumentation plays a big part here. Phosphorus feed to the chamber ties in electrically with the air blower—when air flow stops the phosphorus feed cuts off. Also, a strict ratio of air to phosphorus feed going to the combustion chamber is maintained (1 gpm. of phosphorus to 1,425 cfm. of air). It's done automatically by a ratio controller which adjusts for changes in the feed rates. This is to insure that all the phosphorus goes to P_2O_5 and that lower oxides are not formed. The ratio provides an 8% excess of oxygen.

▶ **Burning Phosphorus**—Combustion of phosphorus takes place at 3,000 F. in a 4-ft.-dia. by 10-ft.-long combustion chamber. Some of the heat developed is removed by water circulating in a jacket around the chamber. Gases coming out are at 1,200 F. All these carefully controlled conditions produce a product which is 99.9% P_2O_5.

The temperature drop between the chamber and the condenser is another important control point—the temperature of the exit chamber gases affect crystal size.

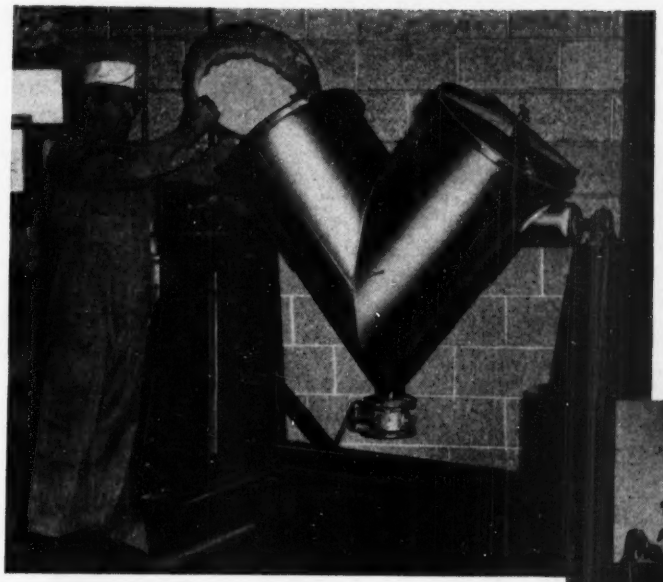
It's done with a diaphragm valve which regulates the flow of water through the combustion chamber jacket. This valve is actuated by any change in the temperature of the gases leaving the chamber.

The gases enter an atmospheric condenser. This is a 40-ft. high, 16-ft. dia. steel tower. Losing heat to the surrounding air, phosphoric anhydride comes out in a "snowfall" of white crystals.

Chains, connected to a revolving wheel near the top of the condenser, sweep along the side and clean off accumulated crystals. From the condenser, the crystals fall onto a screw conveyor. Phosphoric anhydride crystals are packed in air-tight steel drums, sealed with rubber gaskets. This is necessary, because of the great affinity P_2O_5 has for moisture.

Gases exiting (250 F.) from the condenser contain a small amount of P_2O_5. They go into a stainless steel clean-up system.

Here a Haveg venturi scrubber removes entrained P_2O_5—collecting it as phosphoric acid. This acid recirculates through the scrubber until it reaches a high concentration. Then, some is bled off, and water added to the main body of acid.



Charging a p-k Twin Shell Blender through one of the two large access ports at O. M. Franklin Serum Co. plant in Denver, Colo.

Complete discharging through butterfly type valve.

This p-k Twin Shell Dry Blender† gives Denver livestock supply house

"A Thorough Mix of Dry Materials" *

"I have been in charge of various types of production, for the past fourteen or fifteen years" says Kevin M. Curyea, manager of the manufacturing division of O. M. Franklin Serum Co., "but I think this machine (a 5 cu. ft. capacity p-k Twin Shell Dry Blender) is one of the best buys I have ever made. It is simple to load and unload, it is efficient and fast, and it takes up a very minimum of space."

"The average time to blend our dry powders," Mr. Curyea estimates, "is from four to six minutes." And, he adds, "the machine can be cleaned up easily in five minutes."

There is a p-k blender that will make *your* dry mixing operations faster, more thorough and more efficient. Write today for full information.

**All quotations on this page are from a signed letter from Mr. Curyea to the Patterson-Kelley Company, Inc.*

the Patterson-Kelley Co., inc.

190 Lackawanna Avenue, East Stroudsburg, Penna.

† Patented

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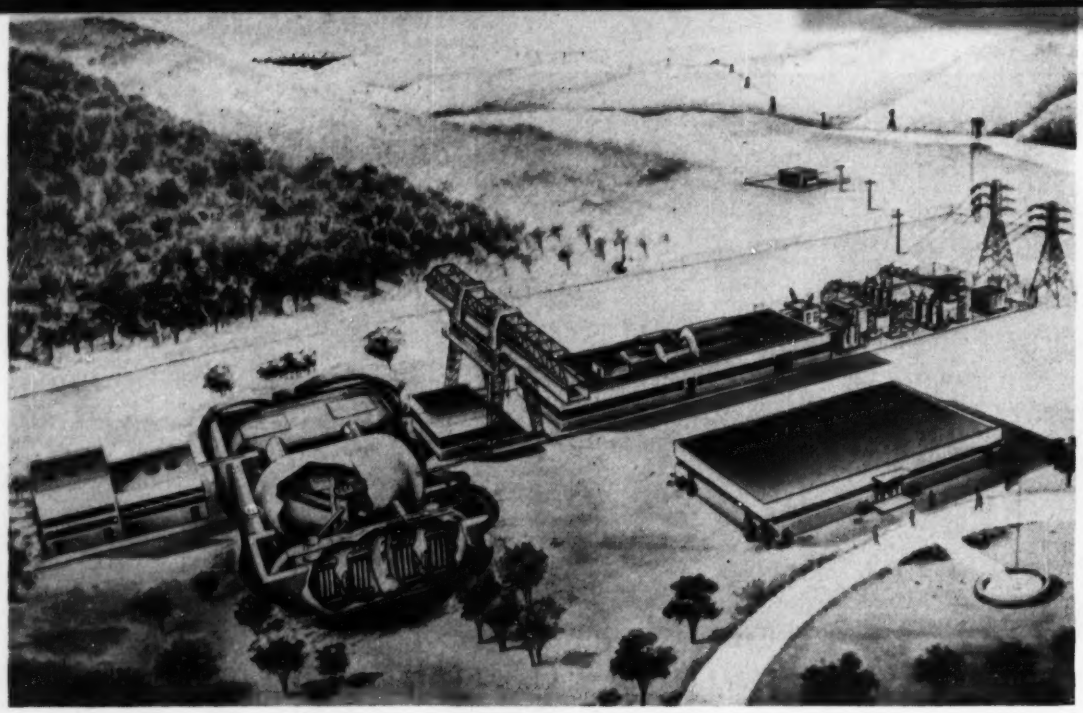
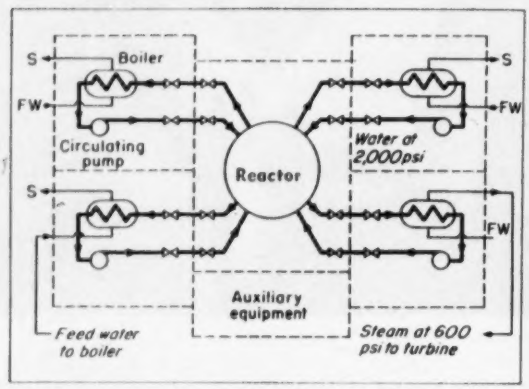
101 Park Avenue, New York 17 • Railway Exchange Building, Chicago 4 • 1700 Walnut Street, Philadelphia 3 • 96-A Huntington Avenue, Boston 16 • and other principal cities.





ARTIST'S sketch, cooling system diagram, and site—Shippingport, Pa.—of first commercial nuclear power plant.

Power From the Atom—It's Almost Here

Latest cost studies make the prospects of commercial nuclear power look better than ever. Westinghouse-Duquesne's 60,000-kw. plant will help show how.

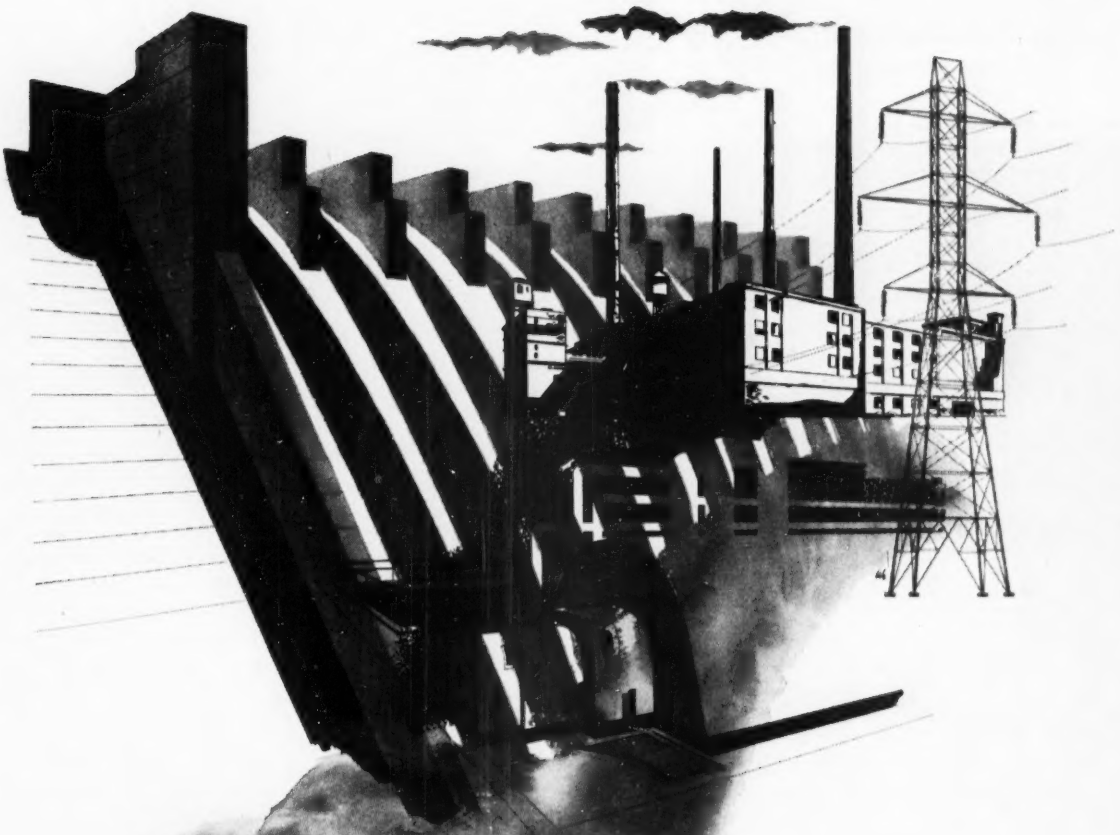
Nuclear power at competitive costs within the next five to ten years—that's the current thinking of those who ought to know.

Even conservative General Electric, previously pessimistic about the prospects of commercial nuclear power in anything less than 15 years, has changed its tune. GE now ventures to predict the cost of electricity from the atom at about 6.7 to 6.8 mills per kwh. At these rates nuclear power plants would be competitive with nearly one-fifth of the large conventional power-generating stations installed in this country in the past two or three years.

GE showed its hand at a meeting of the Atomic Industrial Forum in Washington on May 24. Also presenting their respective company viewpoints at this meeting were men from Westinghouse, Monsanto, Dow, Foster Wheeler and other firms and government agencies vitally concerned with nuclear power development.

▶ **Which Reactor Design?**—In spite of general agreement as to "if" and "when," Forum participants differ widely as to "how." Among the contending reactor designs are these:

• Westinghouse is backing the pressurized water reactor (PWR),



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How General Electric Figures Cost of Nuclear Power

	Graphite Reactor	Boiling Reactor	Coal Plant
Electrical output capacity	700 mw.	300 mw.	300 mw.
Plant utilization factor	0.85	0.80	0.80
Steam temperature	370 F.	450 F.	1,000 F.
Pressure	180 psia.	421 psia.	1,450 psia.
Net thermal efficiency	23%	24%	35%
Heat generated	3,000 mw.	1,250 mw.	857 mw.
Pant investment, $/kw.			
Physical plant	214	195	140
Land	1	2	2
Engineering	17	15	11
Start-up	17	14	7
Nuclear fuel inventory	28	17	—
Total	277	243	160
Cost of electricity, mills/kwh.			
Fuel	1.0	1.35	3.4[2]
Operating cost	0.6	0.70	0.5
Fixed charges[1]	5.2	4.65	3.0
Total	6.8	6.7	6.9

[1]Fixed charges applied to plant, 13.7% of investment; applied to land, 11.4%; applied to nuclear fuel inventory, 9.6%. [2]Coal at $0.35 per million Btu.

in which ordinary water at 2,000 psi. moderates the reactor and transfers heat to exchangers, where steam is generated at 600 psia.

• General Electric is dividing its eggs between two baskets. One is a direct descendant of the graphite-moderated, water-cooled reactors which GE operates at Hanford to make plutonium. This design uses external heat exchangers for generation of steam at 180 psia.

• GE's alternative design is a boiling reactor, which delivers 420-psia. steam directly to the turbines without use of external exchangers.

• Nuclear Power Group* reports the possibility of 7-mill power from a 600-psi. heavy-water-moderated reactor generating steam at 175 psi. via external heat exchangers. NPG, not overlooking other potential designs, is now studying the boiling reactor.

• North American Aviation has worked with a graphite-moderated reactor using sodium as the heat-transfer medium.

• Oak Ridge National Laboratory is plugging its homogeneous reactor. Fuel for this type is carried in aqueous solution and may be reprocessed in a continuous cycle, whereas other reactor types use solid fuel elements that must be withdrawn completely for reprocessing.

• Pioneer Service-Foster Wheeler has dropped its study of a fluidized-solid-moderated reactor in favor of the aqueous homogeneous type.

*Consisting of American Gas & Electric Co., Bechtel Corp., Commonwealth Edison Co., Pacific Gas & Electric Co. and Union Electric Co. of Missouri.

▶Chemical Processing – Low fuel cost is the key to competitive price of delivered kilowatt-hours, regardless of reactor type. One way of keeping fuel cost down is to use natural or slightly-enriched uranium over a long "burn-up" period. GE figures on a burn-up of about 1% of the total atoms of uranium, which implies conversion of a significant number of U-238 atoms to plutonium and subsequent fissioning of the Pu.

Another way to minimize fuel cost is to lower the cost of reprocessing irradiated fuel. Although there is still a long way to go, Walter H. Zinn, director of Argonne National Laboratory, finds "a very positive air of optimism among the chemical engineers who are best qualified to judge." One of Argonne's projects is a breeder power reactor which incorporates in its fundamental concept the idea that fuel will be reprocessed and that the material consumed will be U-238.

Going a step further, Monsanto's Philip Powers argued at the Forum that nuclear power plants should turn out fissionable products for use in weapons and industry in addition to electric energy. He said further that radiation from the reactor might be used to make radioactive substances for the chemical industry.

▶PWR Design – Charles H. Weaver, manager of Westinghouse's Atomic Power Div., described in some detail the pressurized water reactor Westinghouse is designing for Duquesne Light Co.'s 60,000-kw. nuclear power plant to be built near Pittsburgh.

Reactor core will consist of a geometrical pattern of closely spaced fuel elements, composed of slightly enriched uranium protected by a corrosion-resistant metal. These elements will be formed into a cylinder about 6 ft. in diameter and 7½ ft. high. More than 10 tons of uranium will be used in the first core.

The stainless-clad vessel which contains the core will be large enough to accommodate cores bigger than the first one. Its shell will be about 9 ft. I.D., over-all height more than 25 ft.

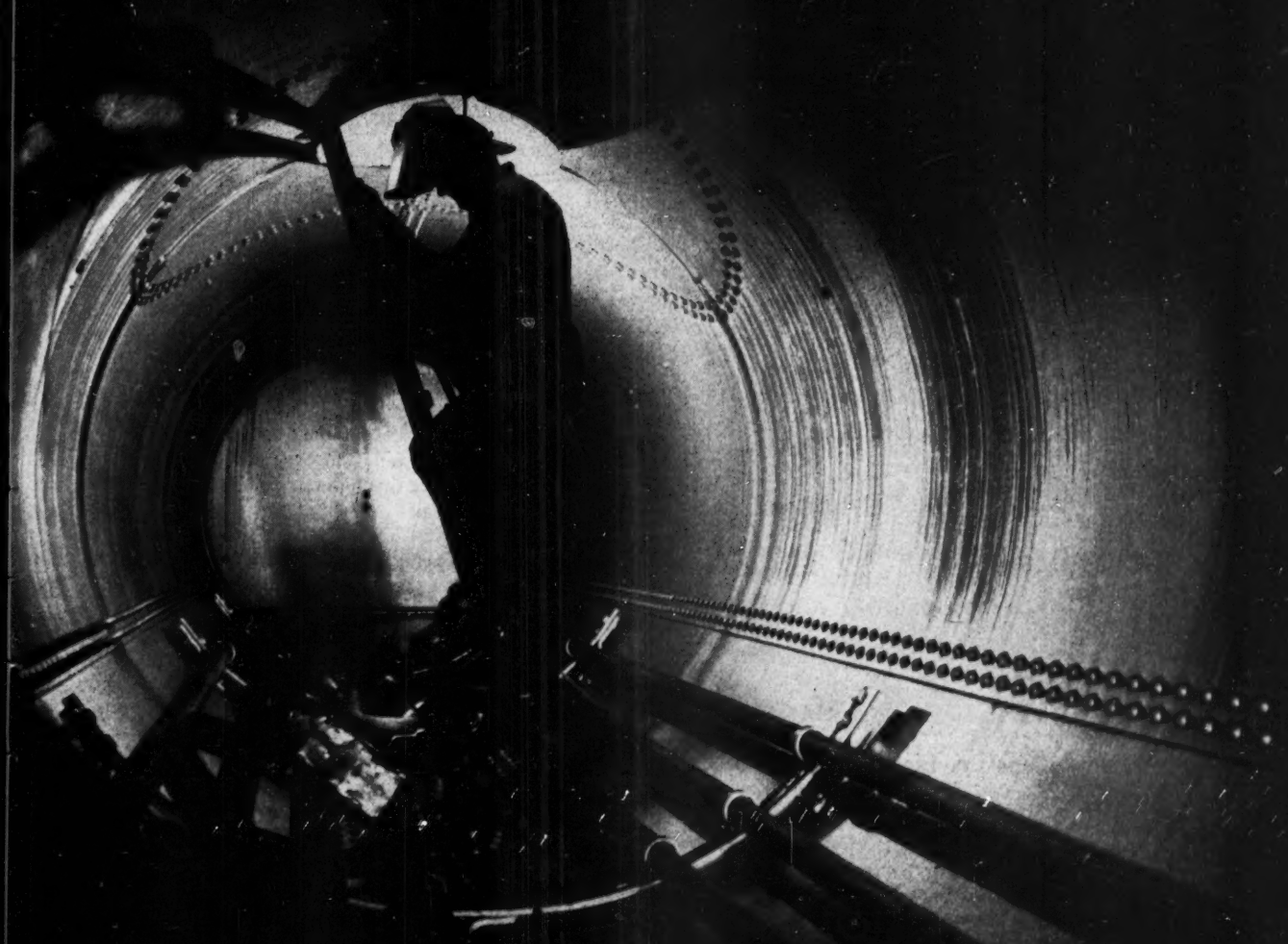
Main coolant system, which serves both to absorb heat generated by the reactor and to deliver heat to the steam generators, will consist of four separate loops. Comprising each loop are a pump, a steam generator, shut-off valves and interconnecting pipe. Each steam generator consists of a water-to-water heat exchanger, steam drum and separator.

With normal operation of three loops, water will circulate through the reactor at a rate of about 48,000 gpm. Water pressure will be 2,000 psi.; average temperature, about 525 F. Pressure will be maintained by a pressurizing tank which floats on the system. This tank is normally filled with about equal volumes of water and saturated steam at more than 600 F. Head of steam is provided by electrical heaters in the water.

"surgery" service for GATX tank cars

For minor or major repairs, GATX tank cars have their own "hospitals." More than 30 General American car repair shops are located throughout the country, so that no car is ever more than a few hours away from professional tank car maintenance. These shops have experts to service the 200-plus different types of GATX tank cars. They have the necessary tools, jigs and fixtures; the testing equipment; and parts inventories. All work can be done under A.A.R. and I.C.C. specifications.

When it comes to keeping the 47,000 cars in the GATX tank car fleet rolling, General American's car repair shops work with the engineering and traffic departments to give shippers more dependable service for transporting liquids in bulk.



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Car repair shops throughout the U. S. A. Offices in principal cities

Pumps will be single-stage centrifugal units driven by canned motors. About 1,000 hydraulic hp. is required per loop, with a power input of 1,200 kw.

Coolant system pipe will be approximately 18 in. O.D., made of stainless steel. Gate valves for shut-off will be hermetically sealed and will operate hydraulically.

The entire primary plant will be enclosed in a steel container to retain any radioactive materials which might escape from the plant as a result of an accident.

▶**Time Will Tell**—Westinghouse feels that it's much too early—cost and technical data are too inadequate—to predict whether any one type of reactor is greatly superior to all others. Westinghouse favors PWR chiefly because it is today better understood than other types. (Westinghouse has already built two submarine engines of this type.)

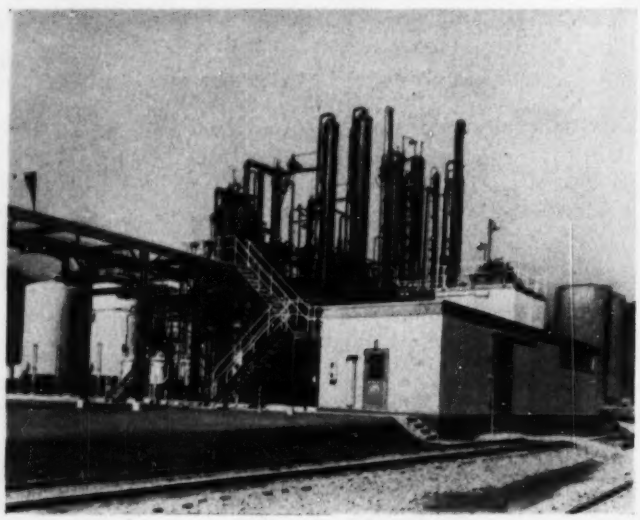
As an example of the difficulties in estimating the cost of a new reactor type without actually designing and building it, Weaver cited the results of a request for fixed-price sealed bids on the PWR steam generators, and also on a prototype main coolant valve. Both bid invitations were based on complete performance specifications. The bids received on each component varied by a factor of almost 5 to 1.

General Electric, in contrast, puts a lot of confidence in its cost estimate for construction of a Hanford-type reactor. This estimate is based on considerable experience in the construction and operation of a number of high-power graphite reactors. The figure of $277 per kw. should provide industry with some assurance that capital costs for nuclear power aren't going to be exorbitant.

Big unknown, however, is fuel cost. GE's assumed 1% burn-up (more accurately expressed as 10,000 megawatt-days per ton) looks good on paper, but remains to be demonstrated.

T. G. LeClair of the Nuclear Power Group pretty well summed up the situation with this statement:

"If we looked only at the unsolved engineering problems in the nuclear power field we would easily get discouraged. Instead, let's look at the rapid progress of the last few years. Compare this progress with that made in any other new industry and you can see that economic electric power generated from nuclear sources may not be far away."



Carbide Ups Production of Acrylic Esters

A "substantial expansion" of ethyl and methyl acrylate capacity has just been completed by Carbide and Carbon Chemicals Co. The new unit (above), located at Institute, W. Va., can also make other acrylic esters used in manufacturing a number of polymers and copolymers.

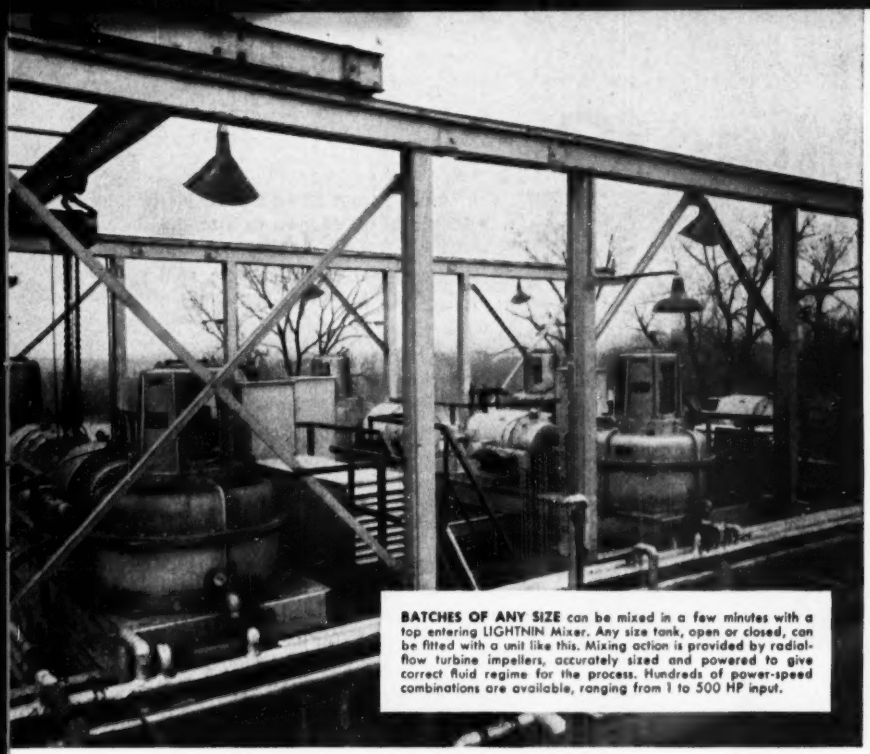
Biggest uses for acrylic polymers are in cast and molded plastics, pressure-sensitive adhesives and lubricating oil additives. The various copolymers find application in emulsion paints, textile and leather finishes, molding and laminating resins and synthetic fibers.

Electro Met Plans Huge Titanium Unit

Although there's been no official confirmation, it seems fairly certain that Union Carbide's Electro Metallurgical Co. is going to build a $30 million, 10,000-ton-per-year titanium plant at Ashtabula, Ohio. And instead of the usual Kroll process, it will probably use sodium to reduce titanium tetrachloride to the metal.

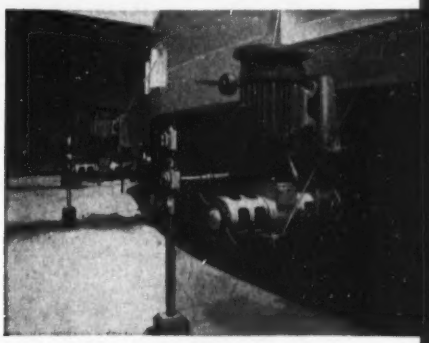
Just when construction will start depends to a large extent on the government. Electro Met is not looking for a loan, but does want a General Services Administration guarantee that the government will pay for the plant if it becomes obsolete (one of the biggest fears of titanium makers). It also wants the government to contract for part of the plant's production as it has done for other titanium makers.

Most likely supplier of sodium and chlorine for the plant is National Distillers. The substantial amount of these materials required would probably require expansion of National Distiller's Ashtabula plant to the tune of about $20 million.



BATCHES OF ANY SIZE can be mixed in a few minutes with a top entering LIGHTNIN Mixer. Any size tank, open or closed, can be fitted with a unit like this. Mixing action is provided by radial-flow turbine impellers, accurately sized and powered to give correct fluid regime for the process. Hundreds of power-speed combinations are available, ranging from 1 to 500 HP input.

MIXING AT AN ANGLE can save cost of baffling the tank. Axial-flow propellers, sized for the job, rapidly turn over and rotate tank contents for thorough mixing. You have a choice of 30 LIGHTNIN Mixers of this type, for open or closed vessels, ranging from ¼ to 3 HP. Many modifications are possible for special needs.



IN VERY LARGE TANKS, you can mix, blend, circulate, suspend solids, with a LIGHTNIN Side Entering Mixer—faster and more cheaply than by any other method. You save on shaft seal maintenance, too, thanks to new easy-to-get-at, easy-operating tank shutoff. Sizes from 1 to 25 HP, for tanks as big as 6 million gallons.

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For best fluid mixing results, choose a mixer that:

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You get *all three* with LIGHTNIN Mixers.

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You can be sure all the power you buy goes into the batch. Efficient use of power is assured by special load-test equipment, plus widest possible choice of standard mixer power-speed-torque combinations.

You get engineering refinements such as flex-protected gearing, interchangeable speeds, simple repacking, easy replacement or change of components—all adding many years of useful life to the mixers you choose—when you choose LIGHTNINS.

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DO HUNDREDS of mixing jobs efficiently, at low cost with LIGHTNIN Portable Mixers. Thousands are in use today. Many in service 20 years and longer. Electric or air motors, direct or gear drive. More than 30 standard models. Sizes ⅛ to 3 HP. Full choice of motors, materials.

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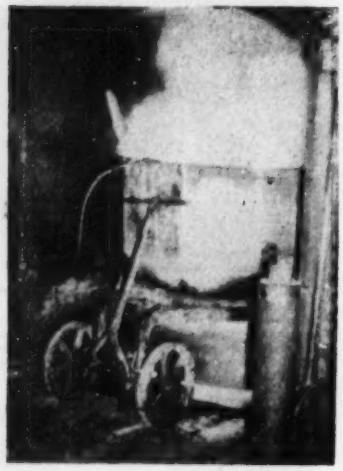
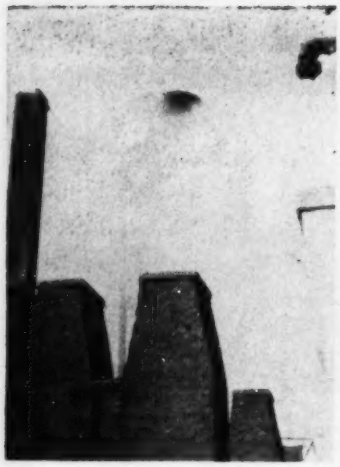
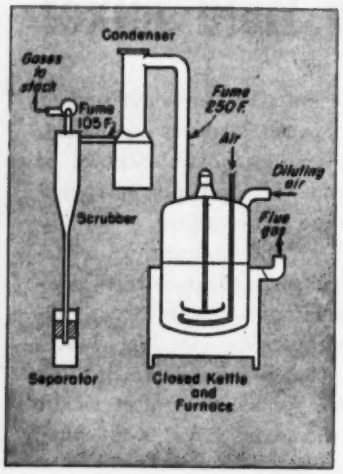




Fumes and Complaints . . .



. . . Knocked Out by Know-How

Cooking oils and resins over open fires in open kettles is a long-established way to prepare varnish . . . and, incidentally, to spew clouds of malodorous fumes.

So obnoxious were these vapors at Du Pont's varnish plant in Flint, Mich., that the company undertook a three-point control program.

• Closed kettles and fires hammered irritant fumes from 2,000 cfm. down to 45 cfm., yield loss from 100 to 50 lb. of oil per batch.

• Orifice-cyclone scrubber squeezed out 25 lb. more oil per batch, got fumes down to a barely passable level, cost less than $1,000 installed.

• Condenser dropped fume temperature low enough to liquefy all components, picked up remaining 25 lb. of oil per batch.

Result: a fume-free atmosphere.

▶ **Cutting Fume Down to Size**—Installation of a closed, 1,000-gal. kettle, supported by a prefabricated radiant gas furnace and equipped with vapor, fume and air lines, reduced fume volume to manageable size while maintaining production. New equipment isolates kettle fumes from combustion products, yet cooks as much varnish as Du Pont had been handling in four open kettles set over open fires.

Previously, kettle fumes, residue gas from air blowing, combustion products from the heat source and natural draft air from the cooking floor had added up to 2,000 cfm. of acrid smoke containing acrolein, acetic and formic acids, aldehydes and entrained oil. A unit to treat this amount of fume faced difficult mechanical problems and would have been impossible to justify costwise.

▶ **Cyclone Takes Over**—With fumes cut down to size, Du Pont's engineers next put to work an orifice-cyclone scrubber able to handle mist, fume and dust particles as fine as 5 microns in diameter. For the job at Flint, the unit is simple, low in first cost, low in operating cost and not at all critical in adjustment.

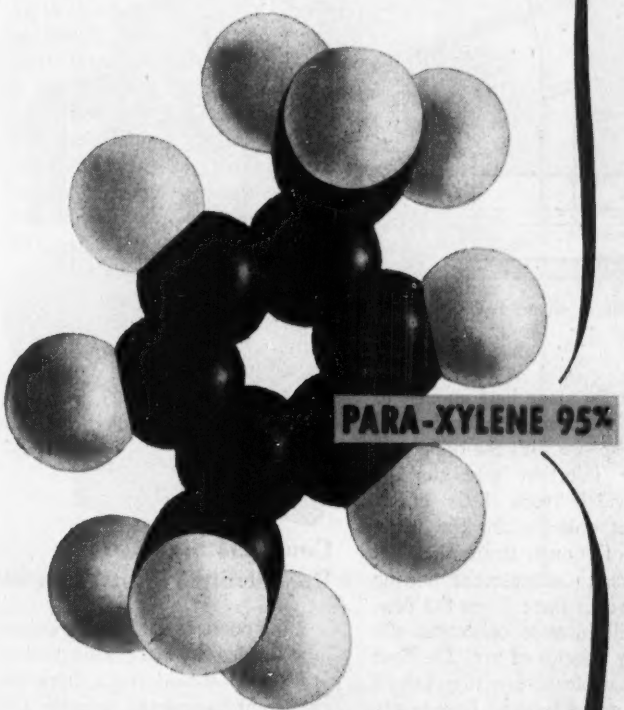
A centrifugal exhauster at the end of the system pulls fume and bypass air into the scrubber through an orifice plate which increases their velocity. Water dribbled into the line ahead of the orifice is atomized and mixed with the vapors. Additional mixing of fume and water, as well as particle growth, occurs between orifice and cyclone. As the fume enters the cyclone tangentially through a rectangularly shaped duct centrifugal force causes now-agglomerated particles to move transversally with respect to residual fume, completing the contacting operation and, finally, separation of the two. Liquids drain to a separator which acts as a seal to prevent short-circuiting of the cyclone and as a still chamber where water and recovered oils may separate.

▶ **Scrubber Highlights**—An inlet velocity to the cyclone of 50 ft. per sec. is a reasonable starting point for design. After sizing the

Oronite
PARA-XYLENE 95%

has many potential uses in chemical synthesis

This important chemical may be oxidized to terephthalic acid, a new dibasic acid useful as a chemical intermediate and in the production of polyesters, polyamides, and other high polymers. Inquiries welcomed.



Chemical Synthesis Possibilities

Process	Product	Usage
Oxidation.	Terephthalic acid.	Formation of polyesters, polyamides, etc.
Oxidation.	Para-toluic acid.	Synthesis of dyes.
Oxidation.	Para-tolualdehyde.	Condensation with polyvinyl alcohol for adhesive resin.
Oxidation.	2, 5-Dimethyl-hydroquinone.	Stabilizing agent.
Oxidation.	Terephthalal-dehyde.	Resins by condensation with diamines or sodium acetate.
Oxidation and chlorination.	Tetrachloro-terephthalic acid.	Flameproof textiles.
Oxidation and chlorination.	Tetrachloro-para-toluic acid.	Alkyd resin modifier.
Chlorination.	Tetrachloro-para-xylene.	Dielectric, heat transfer medium.
Chlorination and hydrolysis.	Para-xylyl alcohol.	For xylyl phosphate. Waterproofing agent. Cellulose ethers.
Chlorination hot or in ultra violet light.	Para-xylyl chloride.	Lachrymatory.
Dichlorination at boiling or in ultra violet light.	Para-xylylene chloride.	Synthesis.
Chlorination and hydrolysis.	Para-xylylene glycol.	Modification urea - formaldehyde resins.
Chlorination in dark with iodine or iron as catalyst.	2-Chloro-para-xylene and 2, 5-Dichloro-para-xylene.	Solvent and/or intermediate.
Chlorsulfonation and reaction with ammonia.	Para-xylene 2-sulfonamide.	Aldehyde resins. Cellulose acetate solvent.
Nitration.	2-Nitro-para-xylene.	Solvent.
Nitration and reduction.	Para-xylidine.	Dyestuffs.
Dinitration.	2, 6-Dinitro-para-xylene.	Dye synthesis.
Sulfonation.	Para-xylene 2-sulfonic acid.	Intermediate.
Sulfonation.	Para-xylene 2, 5-disulfonic acid.	Dyestuffs.
Sulfonation and caustic fusion.	Para-xylenol (2, 5-xylenol).	Making dimethyladipic acid, antiseptics.
Acetylation in presence $AlCl_3$	2-Para-xylyl-methyl ketone.	Perfume bases. Pharmaceuticals.
Ethylation and dehydrogenation.	Vinyl para-xylene.	Molding compounds. Synthetic rubbers.

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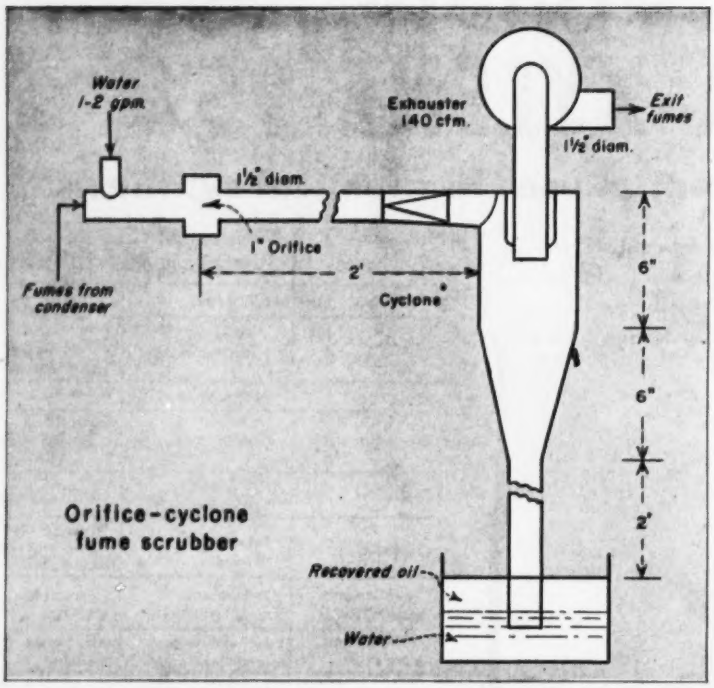


MODEST UNIT serves 1,000-gal. cooker, saves 50 lb. of oil per batch.

inlet to the cyclone on this figure (1¼ in., based on 45 cfm.), the other dimensions can be calculated (see Perry's Handbook, 3rd Edition, p. 1024, Fig. 120).

Since collection efficiency increases rapidly when the pressure drop across the system rises above 10 in. of water, the first blower used was rated at 1 in. Hg and 80 cfm. Bypass air admitted just above the kettle made up the difference between kettle air plus fume (45 cfm.) and the blower capacity. The unit can be run without the bypass but the efficiency of the cyclone improves rapidly as velocity through it increases.*

Geometry of the contacting unit is not critical; total pressure drop, other things being equal, is a measure of the expected collection efficiency. The pipeline contactor between orifice and scrubber may, therefore, be made long enough to develop sufficient frictional head loss to dispense with the orifice.

Water injection rate can be varied widely with little effect. Some authorities claim the introduction of enough steam ahead of the orifice to saturate the flowing gas to two or three times the dewpoint will increase collection efficiency by a factor of five. Du Pont noted that steam injection helped but did not determine how much.

▶ **Cooling Is a Must**—Although the scrubbing unit was yielding 25 lb. of oil per batch, at times a trace of odor was detectable on the ground 200 ft. from the stack. So Du Pont inserted an existing condenser in the system, dropping vapor leading to the scrubber to 105 F., the boiling point of the most volatile component in the varnish fumes, acrolein. Collected oil jumped to 50 lb. per batch and the fume problem was solved.

▶ **Final Touch**—But the explosion hazard urged Du Pont one step further. The last setup described provided only the very minimum amount of diluting air. In order to meet recommended specifications for combustibles concentration, Du Pont enlarged exhauster, cyclone, orifice and piping to handle 470 cfm.

Based on paper by C. R. De Bow, Supervisor in Du Pont's Fabrics and Finishes Dept., presented at 1954 Southern Industrial Wastes Conference, Houston, Tex.

* One day a flashfire occurred in the kettle and stack, a warning that fume concentrations in the system were above the explosive limit. The exhauster was upped to 140 cfm. at 70 F. and 3.6 in. Hg; diluting air was drawn into the scrubber through the kettle rather than from outside; natural draft air was admitted to the bottom of the stack to eliminate a possible pocket for spontaneous combustion.

National Lead to Make More Titanium Dioxide

Construction is beginning immediately on a new titanium dioxide plant for National Lead Co. at St. Louis, Mo. Additional annual capacity will total about 36,000 tons. Initial production is scheduled to begin in July 1955, with full operation set for the end of next year.

At present the St. Louis plant is limited to production of calcium base titanium pigments. The new facilities, however, will be capable of making either calcium base or pure pigments, thus greatly increasing the company's operating flexibility.

Employment at the old plant, which started up in 1923, currently runs about 1,200. After the expansion is completed, about 300 more workers will be required.

Contracts Signed for Rocket Fuel Pilot Plant

A big boost in engineering know-how needed to make solid rocket propellants should result from an agreement completed recently between the U. S. Air Force and Standard Oil of Indiana. Under its terms, Standard will build and operate a pilot plant at Seymour, Ind., to make certain new types of these solid fuels. The Air Force will supply construction funds.

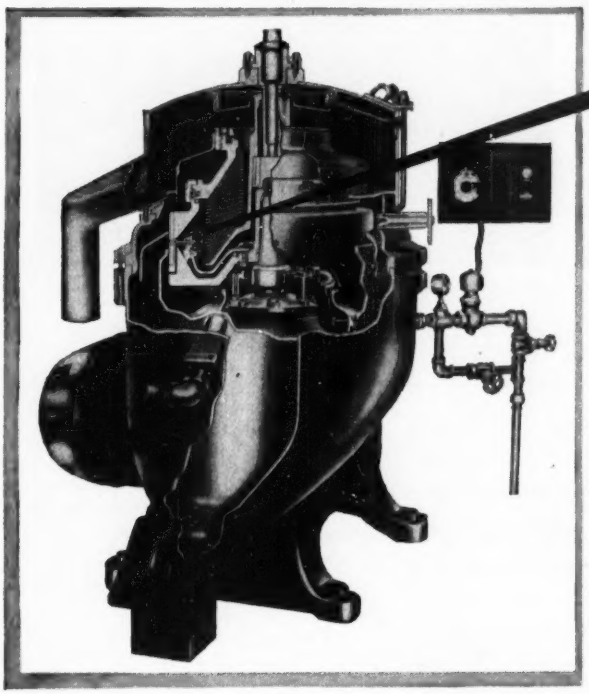
Probably the biggest potential value of solid propellants is their low cost, compared with other types of rocket fuels. Although their makeup is still secret, a large part comes from petroleum.

In operation, solid fuel burns in a closed chamber. Resulting gases are ejected through a nozzle to form a jet which generates a large thrust to drive the rocket.

SHARPLES DV-2

the centrifuge with

external control of solids consistency



Merely by setting two externally mounted timers, the discharge valves of the Sharples DV-2 may be controlled as desired—both for frequency and duration of valve opening. As a result, this high speed disc type centrifuge provides great flexibility for the control of the consistency of the solids which are discharged continuously—flexibility that means process control.

In many applications a firmer cake can be built up by lengthening the time between valve openings, with attendant drier discharge. By adjusting the duration of valve opening, contamination of solids by liquids can be minimized, or valuable liquids may be withheld from the solids discharge. By controlling both frequency and duration of valve opening, desired concentration can be accomplished.

The ten externally controlled valves in the DV-2 clarifier or separator, are operated by the admission of water or other operating liquor through a completely closed system, separate from the material being centrifuged. The large diameter valve ports are of the non-clogging removable type; wearing parts are selected for maximum abrasion and corrosion resistance.

It will pay you to investigate the advantages of the Sharples DV-2—the nozzle centrifuge with positive, externally controlled solids discharge valves.

Do you need accurate, rapid particle size distribution analyses? Ask for Bulletin 101 The Sharples Micromerograph

The Sharples Corporation will be glad to answer questions specific to your problem; Bulletin 1243 will be sent upon request

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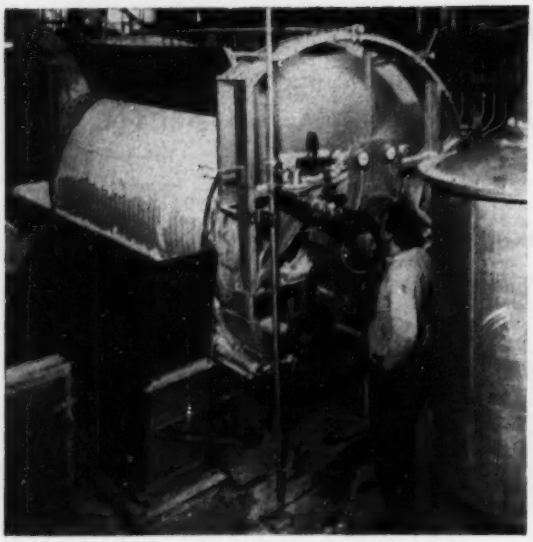
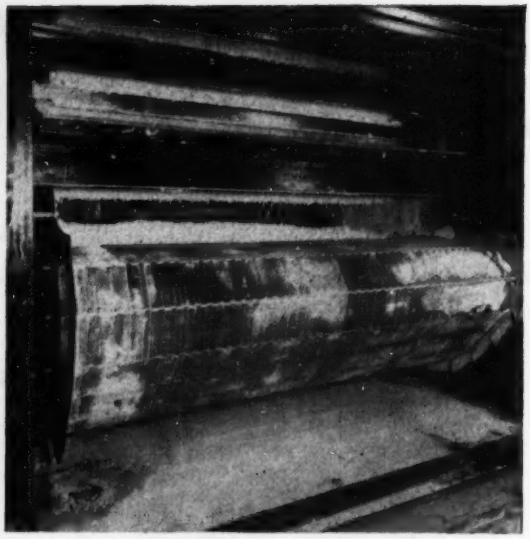


Problem: new resin in demand; continuous filter . . .



and conveyor dryer available for use. It was . . .

Solved by Syneresis*

Goodyear's technique for synthetic resins now successfully developed to plant scale. Unique process removes water without evaporation or mechanical means.

As a logical outgrowth of the war-fostered synthetic rubber industry, a series of copolymers known as rubber reinforcing compounds were developed. Like GR-S these resins were copolymers of butadiene and styrene. But by using a higher proportion of styrene than that used in GR-S, the products are hard thermoplastic resins instead of rubbers.

Commercial demand for these resins developed at the same time that the postwar demand dropped sharply for synthetic rubber. With surplus plant capacity as an incentive, Goodyear Tire & Rubber Co. asked its chemical engineering laboratories if they could develop a resin manufacturing process requiring only a minor conversion of existing plant equipment.

According to P. M. Lindstedt, Goodyear's manager of chemical engineering, dewatering by syneresis is the successful solution to the problem (AIChE Cleveland Regional Symposium, April 1954). The technique has these four definite advantages to recommend it for use:

- Up to 50% of the original moisture in the resin filter cake can be removed without using either evaporation or mechanical means.
- Drying time is cut to less than half of that required by normal evaporation (see graph).
- Syneresis saves almost 5 lb. of steam per lb. of resin.
- Existing plant filters and

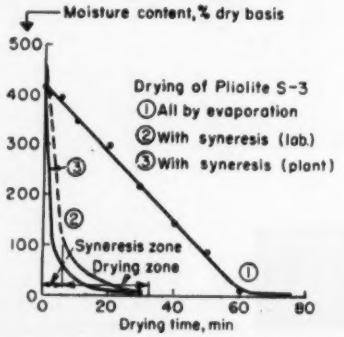
* What's Syneresis?

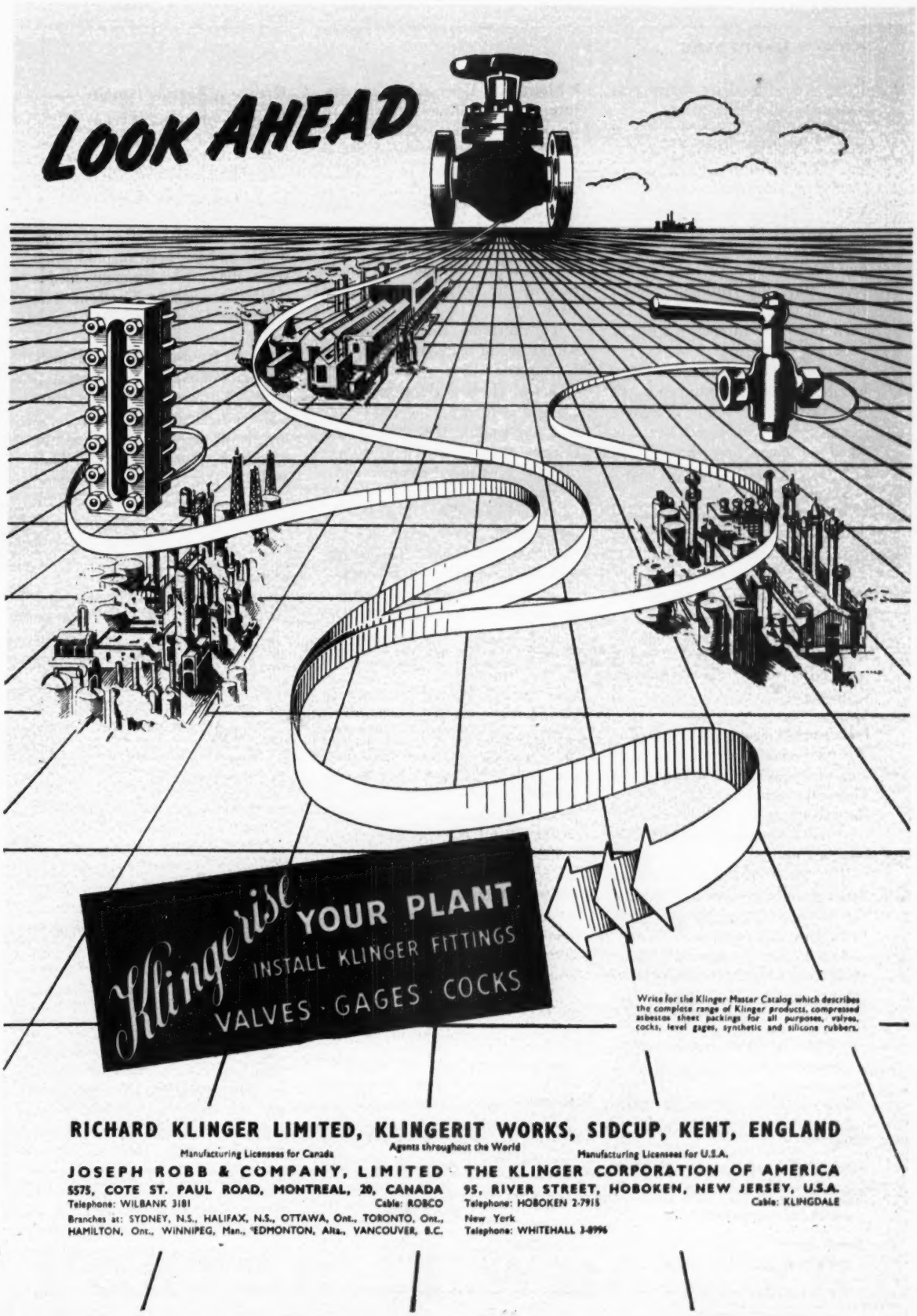
In many cases when a finely divided solid is dispersed in water, a slurry is obtained that thickens to a gel when left undisturbed. The gel is readily broken by simple stirring or shaking, but reforms on standing. This interesting phenomenon is called thixotropy and is a reversible change in consistency due to mechanical shear.

Many thixotropic gels show a tendency to densify slowly on standing with attendant sweating or squeezing out of solvent as a separate phase. This is known as syneresis.

If the temperature of Pliolite S-3 resin filter cake is elevated to its softening point without allowing it to dry, a sudden agglomeration results expelling the water as free liquid. The similarity to the shrinkage of colloidal gels led to the naming of this process "dewatering by syneresis" even though it is not reversible with temperature.

Drying curves for evaporation with and without syneresis are shown below.





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dryers can be used for the process with only minor conversion.

Application of the dewatering method to plant scale has been carried out with full confirmation of pilot plant results.

▶ **The Engineering Problem**—The conventional air drying equipment used in synthetic rubber manufacture consists of a perforated conveyor travelling through several zones in which heated air is circulated downward through the bed of material.

A crumb of wet rubber is uniformly distributed on the conveyor to a depth of 2-3 in. The layer is sufficiently porous and coarse to allow air circulation through the bed of material without excessive loss of fines.

When resin filter cake was dried under these conditions in the pilot plant, a large amount of shrinkage caused cracking in the bed of material. Non-uniform drying was the result.

In addition the product was too dusty for this type of drying equipment as well as for satisfactory handling of the resin during its end use.

▶ **Fortuitous Observation**—During the pilot plant stage of this problem, it was observed that the wet filter cake could not be stored or shipped for drying tests because the water soon separated from the resin on standing.

The search began to accelerate this removal of water by elevating the temperature of the wet resin to its softening point.

This couldn't be done in a stream of dry air because the evaporative cooling of the resin kept the wet bulb temperature below the softening point of the resin.

▶ **Moist Air Dries**—The temperature of the resin was elevated to the softening point—without allowing it to dry—by circulating air at nearly 100% saturation.

A sudden agglomeration of the resin resulted, expelling the water as free liquid. The exudation of water occurs so spontaneously during syneresis that a flooding condition in the bottom of the resin layer.

To overcome this difficulty, a porous bed of material 4-6 in. deep is formed which gives adequate drainage. This is done by coagulating and filtering the resin latex at a temperature that gives an extrudable filter cake. Then the wet material is extruded through a perforated plate.

To achieve the maximum dewatering effect, the temperature of the resin must be raised to the agglomeration point as quickly and as uniformly as possible. This is accomplished by carefully controlling the bed thickness and maintaining an air velocity of 200 ft./min. through it.

▶ **Advantages Proved in Plant**—In plant equipment the dewatering is even greater than that obtained in the laboratory. In actual plant practice, the relative humidity is controlled at 75% of saturation to prevent condensation on the walls of the dewatering chamber.

Furthermore, the dewatering in the plant is carried out at a higher wet-bulb temperature (165 F. instead of 150 F.). Consequently, the amount of water removed in production equipment is 80% of the original moisture present.

The savings in steam consumption in the syneresis process is shown in the table below.

Steam Savings From Syneresis Process

Moisture in wet cake	4.0 lb./lb. of dry resin
Moisture removed by syneresis	3.5 lb./lb. of dry resin
Total steam to evaporate all moisture (assuming 1.5 lb./lb. of water)	6.0 lb./lb. resin
Total steam to dewater and evaporate residual moisture	1.1 lb./lb. resin
Total steam savings from syneresis process	4.9 lb./lb. resin

Rubber Firms Battle Over Tubeless Tires

B. F. Goodrich Rubber Co. has filed a Federal Court suit accusing U. S. Rubber Co. of infringing on its tubeless tire patent rights. Goodrich claims invention of this type of tire and has been in production since 1947. The company filed a similar suit against Firestone Tire & Rubber Co. in May 1953 that is still pending.

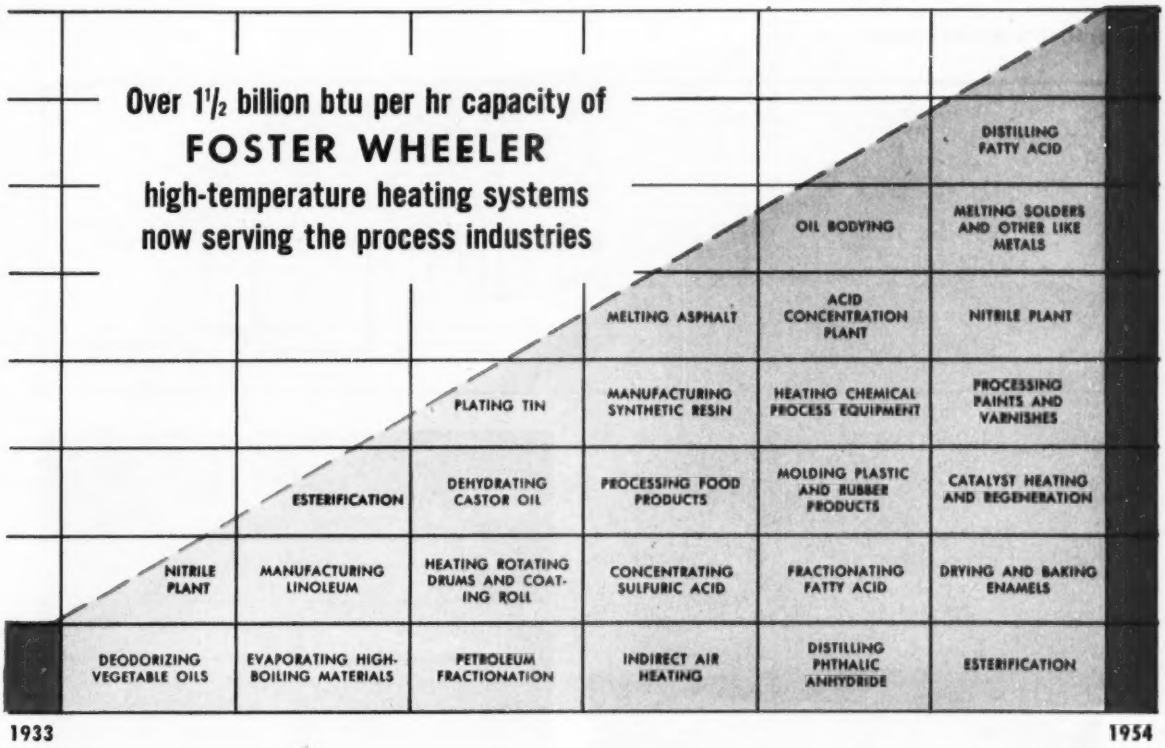
U. S. Rubber officials immediately countered that the patent is invalid because several companies and individuals developed and tested tubeless tires prior to the date of the Goodrich patent. They also said that U. S. Rubber found workable tubeless tires as long ago as 1934.

Oilseed Process Is Commercial Success

Net profit of more than $750 a day is reported by Mississippi Cottonseed Products Co., first user of the packaged oilseed filtration-extraction process developed by the Lukenweld Div. of Lukens Steel Co., Coatsville, Pa. The company's 150-ton-per-day plant at Greenwood, Miss., has met its guarantees in every way.

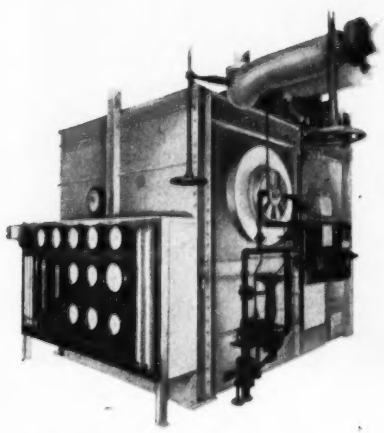
Introduced more than a year ago (*Chem. Eng.*, April 1953, p. 147), the process can alternately charge either cottonseeds or soybeans to make high quality oil and meal directly. And crushers, particularly the smaller firms, can convert economically to solvent extraction from either hydraulic or screw-press operation.

At Greenwood, daily cottonseed throughput over extended periods has been as high as 170 tons. Average operations use 150 tons and yield meal with less than 1% residual oil. Soybeans processed ranged up to 90 tons a day, also with lower than 1% residual oil in the meal. Better than 98% oil yield is attained without prepressing. Only two workers per shift operate the unit, which occupies a space only 20 by 40 by 45 ft. high.



WHAT THIS CHART DOESN'T SHOW—

is the technical knowledge needed to design a heating system right



Foster Wheeler-designed Dowtherm Vaporizer, 4,000,000 btu/hr, 650F, 58 psig.

THE important elements which cannot be shown graphically are the experience and vast technical knowledge which Foster Wheeler engineers have acquired in the design and construction of the specialized equipment needed to do the job right.

Yet it is this know-how that has achieved an unparalleled record of fine performance in nearly five hundred installations. The result of over twenty-one years' experience in the development of Dowtherm high-temperature, low-pressure process heating systems, Foster Wheeler know-how has produced some of the largest systems in operation today (up to 45,000,000 btu per hr at 700F and 88 psi) as well as the smallest (44,500 btu per hr at 700F and 88 psi).

Foster Wheeler's specialized technical knowledge is your best assurance of the *cost reduction* and *product improvement* you are seeking as an economical solution to your critical processing problem. Foster Wheeler Corp., 165 Broadway, New York 6, N. Y.

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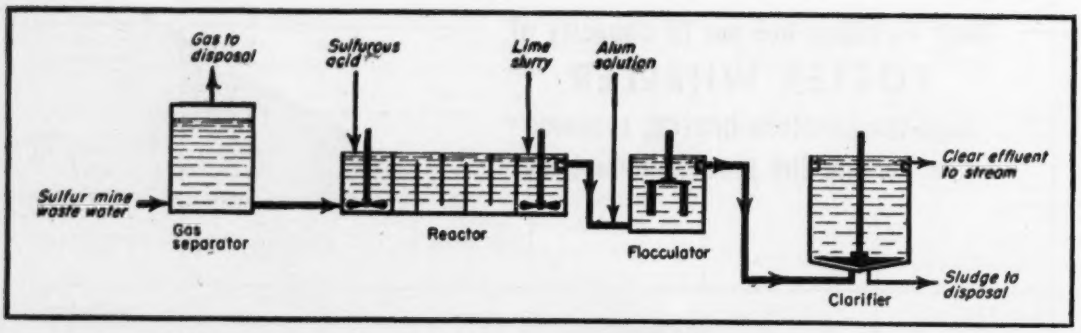
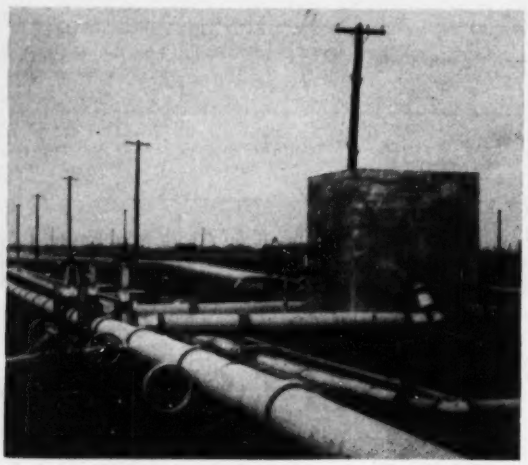
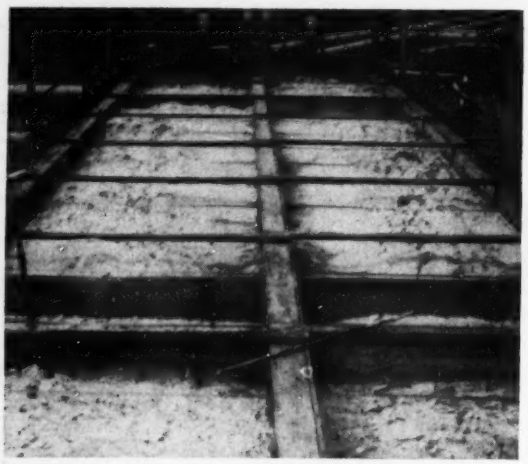
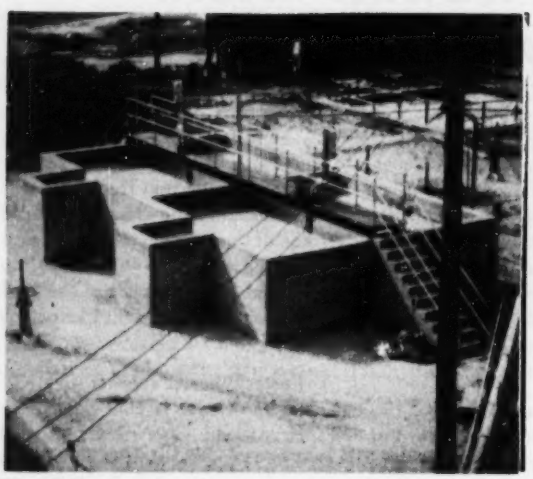




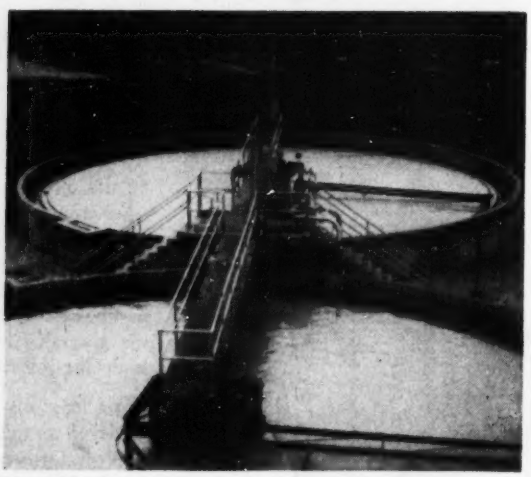
Gas Separator



Reactor



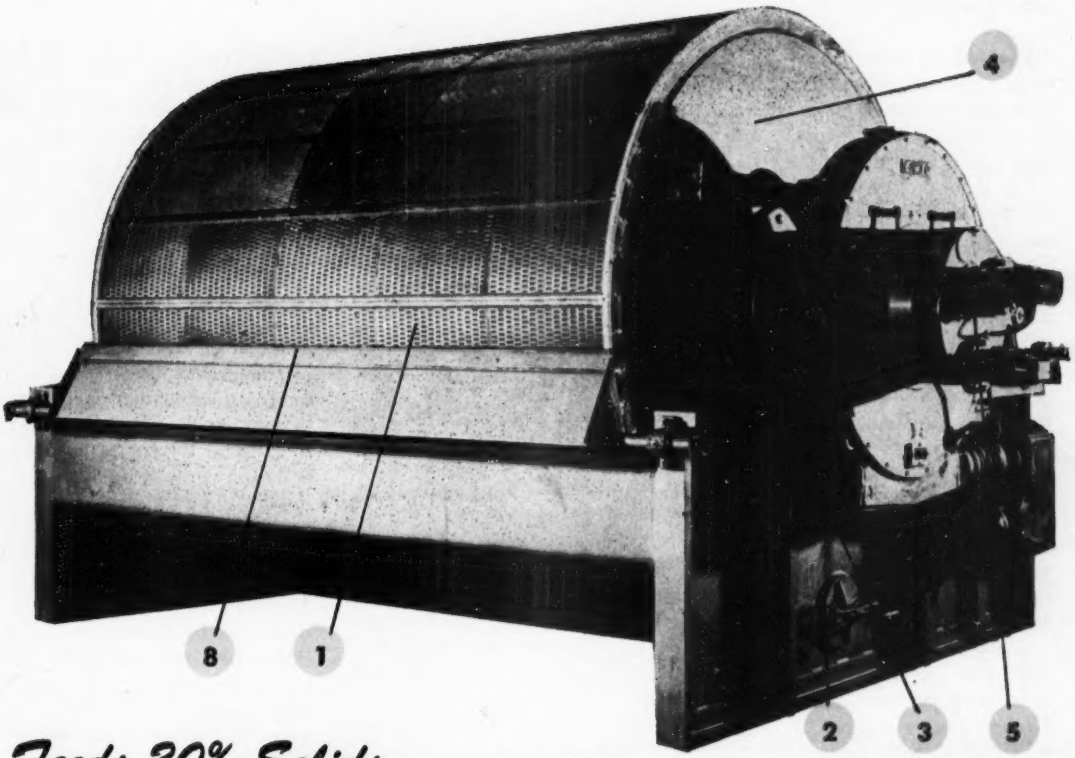
Flocculator



Clarifier

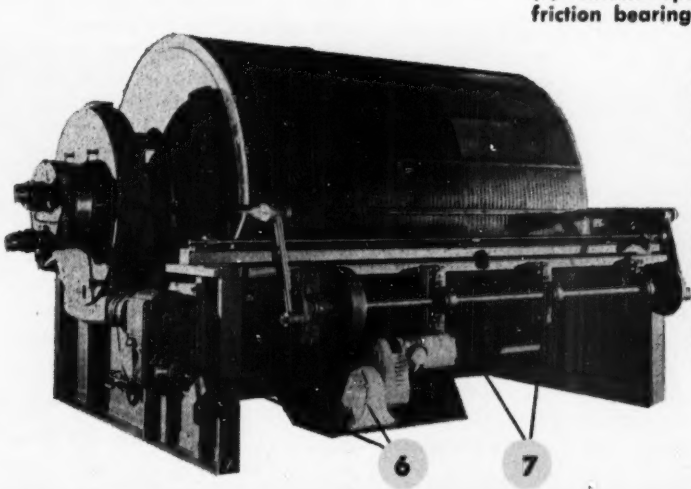
Getting Sulfides Out of Waste Water

Texas Gulf's problem: How to dispose of waste water from the new Spindletop Dome mine? Answer: Treat with sulfurous acid.



Feeds 20% Solids--
Cake 89% Solids

This filter, a standard drum continuous vacuum filter design with most advanced features adapted for the customer's problem, incorporates such items as (1) rubber grids of thermo plastic type, (2) easy access through quick opening tank covers, (3) counterweighted pin type agitators, (4) steel drum-heads mastic coated, snap blow, rubber base plastic piping, (5) marine bronze valve and wear plate, (6) variable speed drives on drum and agitator, (7) anti-friction bearings on agitator shaft.



In operation a dutch weave wire cloth is caulked in the grooves and the snap blow lifts the cake from the panel away from the drum surface so that the (8) rubber tipped blade never touches the drum.

All Eimco filters are engineered and designed with the idea of prolonging cover or bag life. Eimco engineers will consult with you in the selection of the correct media for best filtration and longest life and supply you with samples of Eimco media for your own laboratory work or will advise you on shipment of samples to Eimco Research Center for free filtration analysis.

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You Can't Beat An Eimco

Disposal of sulfur mine waste water is ordinarily no problem at all—not until you locate the mine near an urban area and remote from large bodies of water.

Up against such a problem for the first time in its sulfur-producing history, Texas Gulf Sulphur Co. has successfully developed and put into operation at its new Spindletop Dome mine a novel process for treating 1 million gal. per day of waste water containing 270 ppm. soluble sulfides and 74,000 ppm. NaCl.

Treatment involves reaction of the sulfides in the water with 0.6% sulfurous acid—made by burning sulfur to SO_2 and absorbing the gas in water. Reaction products are colloidal sulfur plus various thionates, polythionates, thiosulfates and sulfates. Sulfur and other insolubles are removed mechanically; the soluble salts remaining are discharged into the adjacent Neches estuary without ill effect.

▶**Playing It Safe**—Fortunately for sulfur producers, most commercial deposits to date have been on the shores of the Gulf of Mexico, usually in sparsely settled areas. Waste water has been ditched directly to the Gulf or to connecting bays. At other mines the water has been impounded and/or aerated to remove sulfides as H_2S and then discharged to a stream; if in fresh water, at low rates or during periods of high stream flow.

Although natural aeration in open ditches is entirely harmless physiologically, H_2S concentration in the surrounding atmosphere is still enough to cause paint blackening and objectionable odors in populated areas. And should sulfide-containing waste water be dumped into a stream, its chemical oxygen demand would adversely affect stream condition.

It's possible to remove sulfides as H_2S by scrubbing the water with flue gas and discharging the H_2S into the air via a stack. This treatment method is well known to the industry.

But company officials responsible for development of the Spindletop Dome mine wanted no part of an operation emitting H_2S to the atmosphere, since there was always the possibility that H_2S might reach ground level, no matter how tall was the stack.

▶**Treatment Process**—Faced with this situation, Texas Gulf chemical engineers turned to the traditional Wackenroder reaction, in which gaseous H_2S is passed into a dilute solution of sulfurous acid to produce a milky, opalescent suspension of colloidal sulfur and a solution of various sulfur acids.

The present process is a logical adaptation of this reaction. The waste water is treated with dilute sulfurous acid, with adequate mixing and retention time, at a pH between 2 and 4.

Although the exact chemical reactions which occur are not fully known, one thing is sure—the process works. It's been operating successfully for two years now, effectively controlling both air and stream pollution.

▶**How It's Done**—Water bled from the bottom of the formation (at the flanks of the dome) is pumped through a 16-in., 1,600-ft.-long Transite line to a gas separator. This is a concrete vessel, 8 ft. square and 15 ft. high. Here, hydrocarbon gases contaminated with H_2S are removed for disposal elsewhere.

The reactor is an open, rectangular redwood tank. At each end are a pair of 10-ft.-square mixing cells equipped with turbine agitators; in between are two parallel, baffled detention tanks, each 10 ft. wide and 90 ft. long. The mixing cells at the feed end, where the H_2SO_3 is added, are covered and sealed against gas evolution; this is the only point at which H_2S tends to be evolved.

Holdup in the reactor is about 2 hr., at a pH of 2.8. Lime slurry is added at the exit end of the reactor to raise pH to 7.2.

Alum is added as the waste water passes to a pair of concrete flocculators, each 18 ft. square and 12 ft. high. Here the liquid is slowly agitated to produce a precipitate with desirable settling characteristics.

Final operation is separation of the precipitate in two 50-ft.-dia. cone-bottom concrete clarifiers. Overflow from the clarifiers is completely free of sulfides and is a relatively stable, neutral, clear salt water.

Dow to Boost Titanium Output

Through a purchase contract with the General Services Administration, Dow Chemical Co. has agreed to substantially increase its titanium sponge capacity at Midland, Mich. Present capacity of 600 pounds a day will be upped to 1½ tons a day by the end of next year, to five tons a day by July 1, 1956.

The new contract brings total planned U. S. titanium capacity to 15,000 tons a year. The biggest producer will be Kramet, Inc., a subsidiary of Crane Co., with 6,000 tons a year. Titanium Metals Corp. of America and Du Pont will produce 3,600 tons each and Dow, 1,800 tons.

Pacific Northwest Set for Natural Gas

Two monstrous pipelines, totaling over 3,300 miles in length, have been approved by the federal government. One will bring natural gas from Colorado to the Pacific Northwest, the other, petroleum products from Texas to New Jersey.

Undoubtedly the most important of the two is the natural gas project because the Pacific Northwest is the only important area in the U. S. now without natural gas service. The 1,466-mile mainline (from Ignacio, Colo., to Bellingham, Wash.) will be built by Pacific Northwest Pipeline Co. of Houston, Tex., at a cost of $160 million. Plans call for transmission of 279 million cu. ft. of gas daily the first year, 365 million in the third year. Completion is expected late next year.

In approving this application, the Federal Power Commission turned down six other companies that proposed bringing the gas in from Canada. Biggest contender was

DAVISON BULLETIN

LIGHT AS A FEATHER — SYLOID® 244

Syloid 244 is a highly porous pure silica gel of extremely low density. A free-flowing white powder, it appears as a fluffy snow weighing 4-4.5 pounds per cubic foot as shipped. Syloid 244 has an apparent particle size of 2-3 microns, yet individual particles are predominantly below one micron.

The chemical and physical characteristics of Syloid 244 makes it adaptable for many uses including the following:

- anti-blocking of clear plastic film
- an additive to inks for quick-drying
- a vinyl flatting agent
- anti-caking for powdered products
- thickening agent for salves, lubricants and plastigels

Progress Through Chemistry

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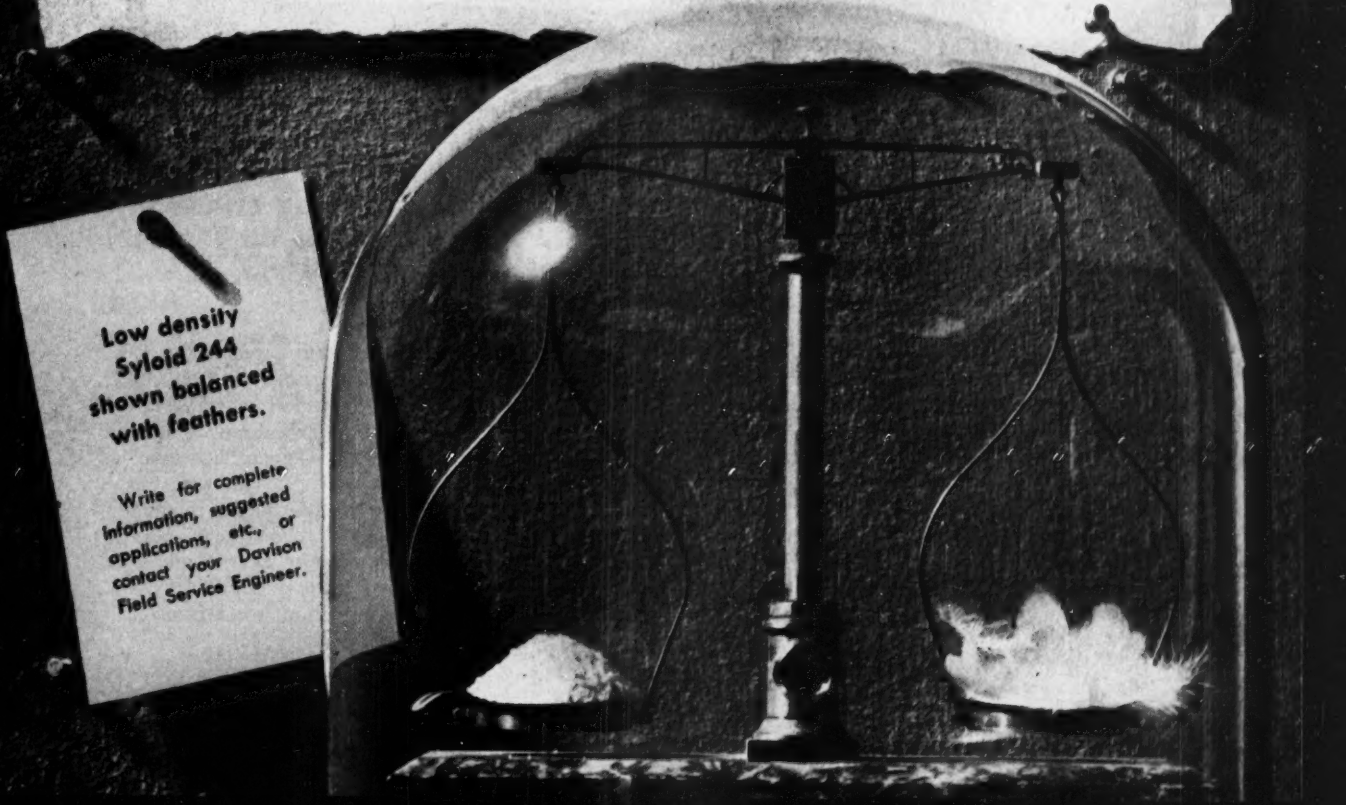
TYPICAL CHEMICAL AND PHYSICAL CHARACTERISTICS OF SYLOID 244

Color	white, 94 Hunter reflectometer; transparent in vehicles
Appearance	uniform, free-flowing powder
Density	
as shipped	4-4.5 lbs./cu. ft.
centrifuged in toluol	7.5 lbs./cu. ft.
true (specific gravity)	2.1-2.2
pH	7.2
Silica as SiO_2 (dry basis)	99.5%
Oil adsorption	240 lbs. oil/100 lbs. SiO_2
Surface area (nitrogen)	292 M_2/gram

PARTICLE SIZE DISTRIBUTION BY WEIGHT

(water sedimentation)

5%	less than 1.1 microns
10	1.4
20	2.0
40	3.0
50	3.7
60	4.5
80	7.0



Low density Syloid 244 shown balanced with feathers.

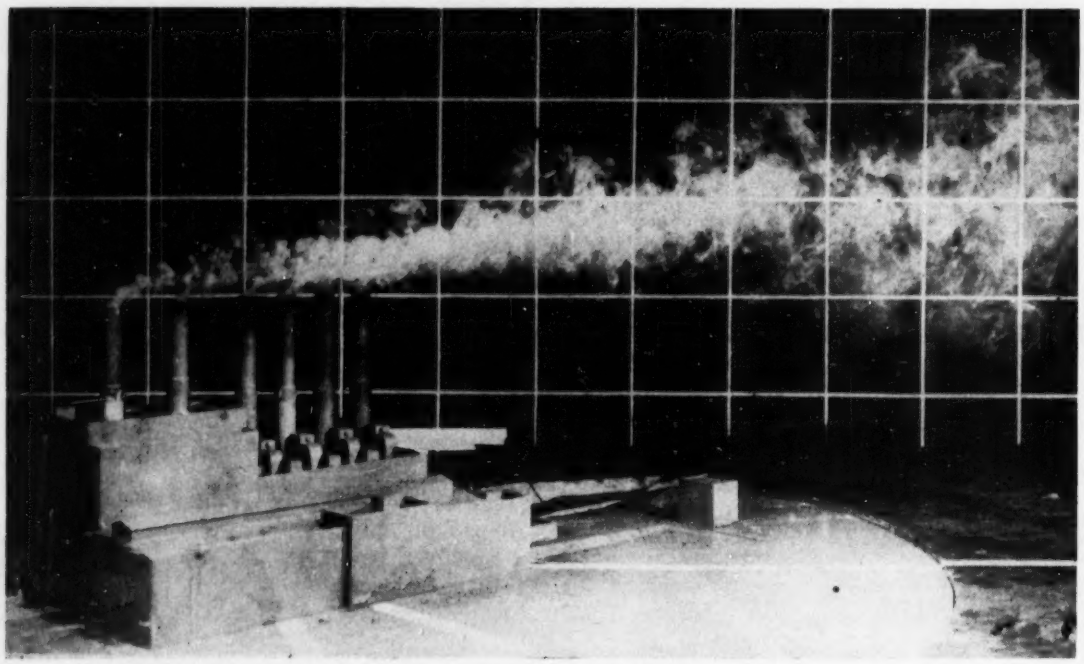
Write for complete information, suggested applications, etc., or contact your Davison Field Service Engineer.

Westcoast Transmission Co. of Wilmington, Del., which wanted to build 270 miles of mainline and 126 miles of branch lines from the U. S.-Canadian border near Sumas, Wash., to Portland, Ore., for an estimated $21.3 million.

The reasons given by FPC for picking the longer, much more expensive system was that the shorter lines would not serve as great an area and that it would not be in the public interest to have sole control of Pacific Northwest gas under control of a foreign power. Commission chairman Jerome K. Kuykendall dissented from the majority opinion, stating that the area might be "better and more cheaply served" by Canadian gas. Also, he did not share his colleagues' apprehensions over the use of Canadian gas as a major supply for the affected market area.

The other important pipeline decision was in favor of a 1,910-mile line from Beaumont, Tex., to Newark, N. J. It will be built by American Pipeline Co., New York City, for $170 million, 40% of which has received a fast tax write-off from the Office of Defense Mobilization.

Capacity of this line will be 500,000 barrels of liquid petroleum products a day, although only half of this will normally be used. The excess capacity will serve as defense stand-by. Line diameters are 26 inches from Beaumont to Louisville, Ky., 24 inches from there to Newark. There will be about 15 take-off points.



Model Traces Industrial Smoking Habits

Newest weapon in the war against air pollution is the use of scale plant models in a wind tunnel. Operating on the theory that air itself is the most efficient purifying agent, engineers at New York University are aiming at finding means of keeping gases afloat. If airborne industrial waste can be dispersed high and wide enough in the air, the biggest part of the problem is solved.

Unlike aircraft wind tunnels that study only air, the NYU pollution tunnel must simulate two fluids—the atmosphere and stack gases. In addition, a variety of temperature conditions must be produced and more complex measuring devices are needed. One of the most useful instruments is a light beam-phototube combination that detects exactly when and where smoke plumes touch the ground.

Once the contributing factors to downwash of gases have been determined, operators of the test can study effective means of controlling them. These include use of higher stacks or nozzles, vanes on the stacks to guide the gas, diluting the gas with air to increase its speed and using vanes to correct unfavorable wind patterns caused by the physical structure of the plant buildings.

Vinyl coating users agree . . .

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MORE MILS PER GALLON WITH AMERCOAT 33

Amercoat's higher solids content gives you a thicker, heavier coating—more mils for every gallon applied.

THIS MEANS YOU SAVE MONEY TWO WAYS ON MAINTENANCE PAINTING

Lower Material Cost. You save on material because it takes fewer coats of AMERCOAT 33 to build the required film thickness.

Lower Labor Cost. You save on labor because fewer coats mean fewer man hours for application–less down time, too.

In addition to more mil thickness per gallon, you get more protection per gallon. AMERCOAT 33 is formulated specifically for maximum chemical resistance and for severe weathering conditions. In major industries from coast to coast – chemical, petroleum, pulp and paper, food, and many others – maintenance engineers look to AMERCOAT 33 for low cost, long lasting protection for all types of steel or concrete structures.

Amercoat pioneered the development of protective coatings especially designed for severe corrosion problems. Today it is the only organization that offers you... a complete line of corrosion resistant coatings...nationwide distribution... trained technical men to give you on-the-job assistance throughout the United States and Canada.

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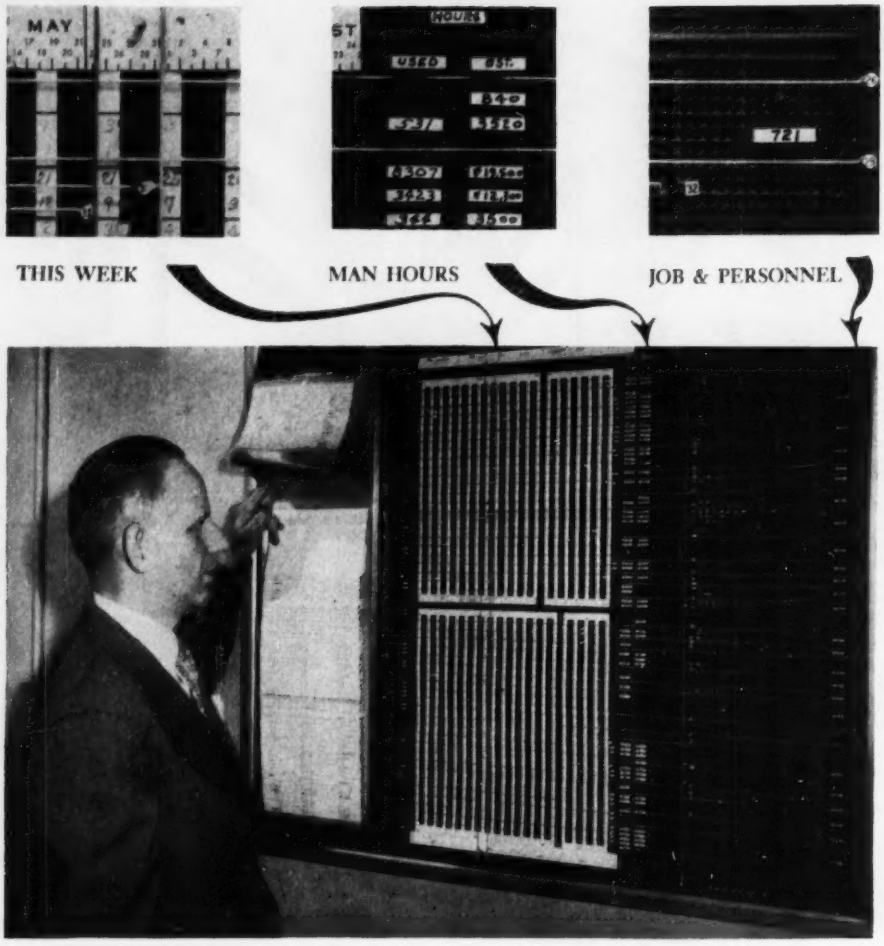
Write today for the AMERCOAT 33 Technical Bulletin which gives a complete description of the coating's chemical and physical properties.



PEG BOARD, modified from the familiar production control board, solves problem of . . .

How to Keep Track of Your Men and Jobs

Many large engineering offices are plagued with a communication problem. How can management be kept informed—simply and quickly—of the status of various projects?

Until recently, there was a lot of talk about how to solve this problem, but nobody did much about it.

Now James P. O'Donnell Engineers*—faced with the task of keeping tabs on over 100 engineers, designers and draftsmen, working on 15 or more engineering projects at one time—has come up with an effective answer.

The solution? A modified pegboard (see cut), of the type commonly used in production control. Using colored pegs and strip cards, the board gives at a glance:

• A quick over-all picture of jobs in progress. It gives the answer to such questions as: how much of each job is complete? How many man-hours have been used?

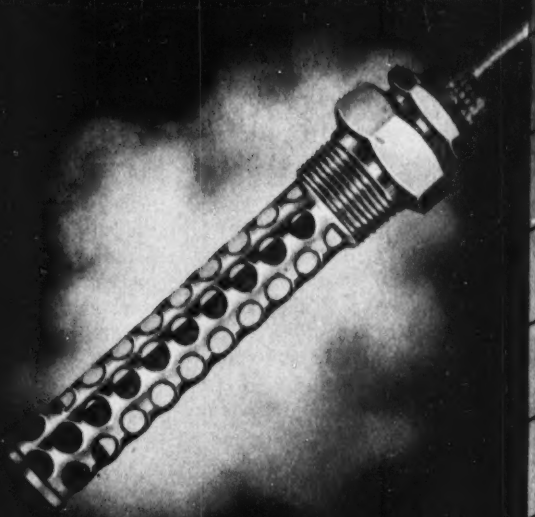
• Potentialities for new jobs. It does this by showing the estimated number of men required for each job—and the actual number. Any manpower deficiency or overload on any job is easily spotted by the use of colored (red and blue) pegs.

• Status reports to clients. This was an unexpected benefit. Before, when a client called for a status report, the information was not always immediately available. Now, it's taken off the peg board in a matter of minutes.

▶ **Other Controls**—Actually, O'Donnell—as with any well-run design

* A professional engineering organization, they are involved in surveys, specifications, detailed design drawings, construction supervision and field engineering.

Amazingly simple way to MEASURE DEW POINT



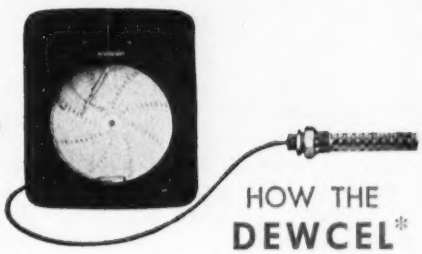
directly . . . accurately . . . continuously

Now you can measure or control the humidity of air or process gases with simplicity and accuracy never before obtainable!

An entirely new-type humidity-sensitive element, the exclusive Foxboro Dewcel*, opens many new possibilities for product improvement in industry. Coupled with a Foxboro Recorder or Controller, the Dewcel offers these outstanding advantages:

1. Direct recording in dew point temperature, at existing pressure.
2. Wide working range — even operates at sub-zero temperatures.
3. Neither adds nor removes water from atmosphere.
4. No water box or circulation of air required.
5. Simplicity that eliminates maintenance.
6. High sustained accuracy.
7. Initial and operating economy.

Investigate Foxboro Dew Point Control for your process. In successful use in nuclear fission, pharmaceutical, food and chemical plants, distilleries, photo film production, drying and storage operations. Write for Bulletin 407. **The Foxboro Company, 369 Neponset Ave., Foxboro, Mass., U.S.A.**



HOW THE **DEWCEL*** WORKS

The Dewcel element is a thermometer bulb (liquid-filled or electric-resistance type) jacketed with lithium-chloride-impregnated woven glass tape. Over this are wound two spaced gold or silver wires connected to an AC source. The lithium chloride absorbs moisture, allowing current to flow, generating heat, and raising the temperature. Equilibrium temperature is reached when vapor-pressure of the moist salt exactly balances that of the surrounding air or gas. The System translates this temperature into direct readings of dew point.

Thus, Foxboro Dew Point Instruments give direct readings or control of dew point from —50°F. to 142°F. at working temperatures from —40°F. to 220°F. Readings easily converted to absolute or relative humidity.

*Trade Mark

FOXBORO

RECORDING — CONTROLLING — INDICATING

INSTRUMENTS

FACTORIES IN THE UNITED STATES CANADA, AND ENGLAND

office—has used controls before the peg board.

One very important control: the engineering and progress schedule sheets on which a complete, detailed account is kept of each project. Usually one or more of these sheets are kept for each phase of a job. If there are five phases (general engineering and 4 design phases—civil, mechanical, electrical, instrumentation) and 15 jobs, that would amount to a minimum of 75 sheets.

Another control: the daily work board. This shows the daily assignments of men to projects.

The peg board does not replace the schedule sheets, or the daily board—each has a definite place in the organization. But the board fills the gap—it gives the over-all view at a glance, on a weekly basis, for a five-month period.

▶ **40,000 Holes**—James O'Donnell has always been interested in developing something to fill the gap between the daily board and the schedule sheets:

"One day I read an advertisement for a production control peg board. It said there were 40,000 holes in the board. And I thought to myself, let's get one of those boards. If we can't make use of 40,000 holes to solve this problem, then there isn't any solution."

▶ **How It Works**—The best way of understanding how the O'Donnell people work with the peg board, would be to trace the development of a typical job as it comes into the office:

1. Manpower requirements are established, based on preliminary engineering and design studies.

2. Usually a job is set up on the board in five major classifications or phases—general, mechanical, civil, electrical and instrumentation.

3. Engineering cards (located at the left side of the board) are filled out showing all pertinent job information.

4. Estimated manpower required for each department is marked in pencil on vertical strip cards. These cards divide the board into weeks of the month. This leaves six holes for each week. And these holes are used to indicate any shortage or oversupply of men in a particular week. Blue peg—oversupply. Red peg—shortage.

The strips are useful in another way. By summing all the scheduled manpower requirements shown on the strips, plus men on vacation—and subtracting this from the total number of men in the firm—you come up with a quick estimate of men available for new jobs.

5. The number of estimated hours for each phase is set up at the right of the strip cards. Every week, actual hours are posted.

6. Every two weeks, a survey is taken of actual percent completion of each phase. The position of round numbered pegs indicate the percent completion of each job.

7. At the extreme right hand section of the board, numbered pegs show the individual men on each job. Red pegs designate "light" personnel—draftsmen, etc. Blue pegs designate "heavy" personnel—designers to engineers.

Two 25,000 Barrel a Day Refineries Planned

At Pine Bend, Minn., Great Northern Oil Co. of St. Paul will build a 25,000 bpd. oil refinery to process Canadian crude. Major units, which will be designed, engineered and erected by Fluor Corp., Los Angeles, include a Thermofor catalytic cracker, an Ultraformer, a Hydro-Desulfurizer and a catalytic polymerization unit. When the plant is completed in August 1955, most of its output will be marketed by Socony-Vacuum Oil Co., Inc.

And at Guayanilla Bay, Puerto Rico, Lummus Co., New York, is designing and building a refinery for Commonwealth Refining Co., Ltd., to process 25,000 bpd. of Venezuelan crudes. A Houdry cat cracker and a Houdry cat reformer, plus alkylation and catalytic polymerization facilities, will be used to make aviation and motor gasolines, diesel oil and fuel oil.

Convention Calendar

1954 International Symposium on Combustion, University of Pittsburgh, Pittsburgh, Pa., Aug. 30-Sept. 3.

Commercial Chemical Development Association, growth and effect of commercial development in the chemical industry, Hotel Statler, New York, N. Y., Sept. 12.

American Institute of Chemical Engineers, national meeting, Hotel Colorado, Glenwood Springs, Colo., Sept. 12-16.

First International Instrument Congress and Exposition, including many technical sessions, Philadelphia Museum and Convention Hall, Philadelphia, Pa., Sept. 13-25.

National Petroleum Association, 52nd annual meeting, Traymore Hotel, Atlantic City, N. J., Sept. 15-17.

Chemical Market Research Association, annual resort meeting, Equinox House, Manchester, Vt., Sept. 20-21.

Technical Association of the Pulp & Paper Industry and Canadian Pulp & Paper Association, joint symposium on "Fundamentals of the Paper Machine," Institute of Paper Chemistry, Appleton, Wis., Sept. 20-24.

Drug, Chemical and Allied Trade Section, New York Board of Trade, 64th annual meeting, Pocono Manor, Pa., Sept. 23-26.

Industrial Packaging and Materials Handling Engineers, ninth annual exposition, Chicago Coliseum, Chicago, Ill., Sept. 28-30.

Symposium on the applications of radioactivity in the rubber and plastics industries, sponsored by Tracerlab, Inc., Sheraton-Plaza Hotel, Boston, Mass., Oct. 6-8.

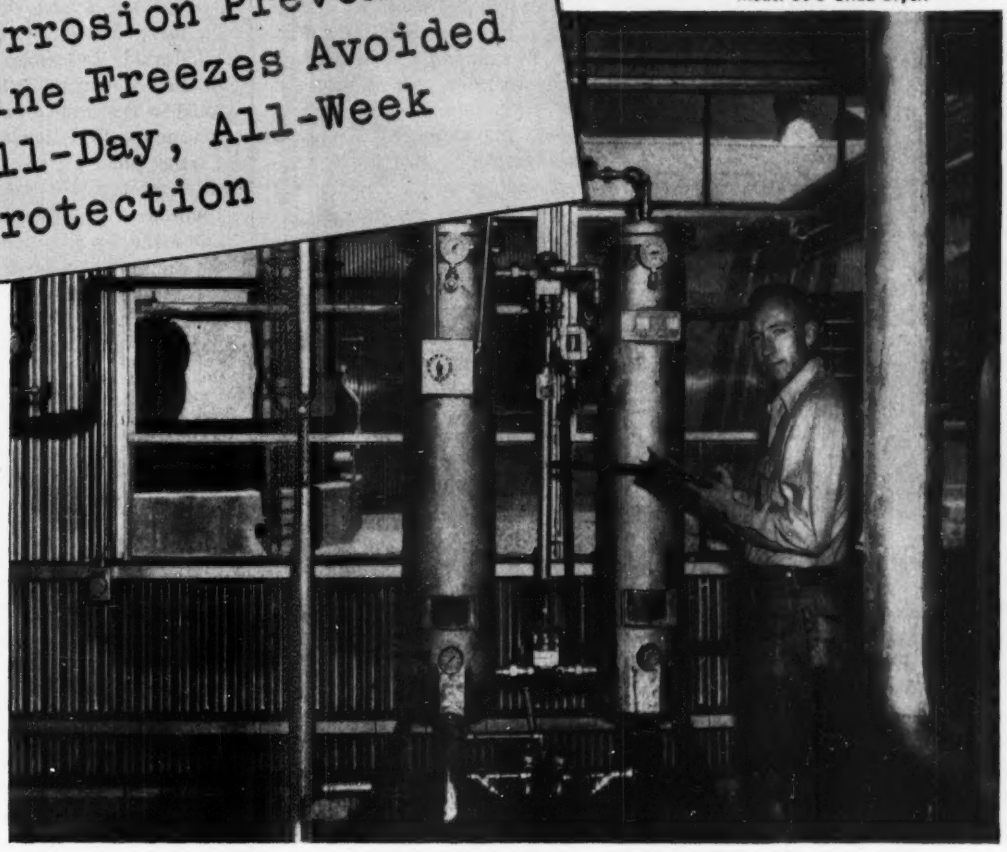
Commercial Chemical Development Association, growth and influence of foreign chemical developments, Bedford Springs Hotel, Bedford, Pa., Oct. 7-8.

American Institute of Chemical Engineers, New York Section, symposia on 1) new developments in the petroleum and chemical industries and 2) cost estimation, Hotel Statler, New York, N. Y., Oct. 13.

Case No. 108

Seaboard Oil Company Reports:

- Corrosion Prevented
- Line Freezes Avoided
- All-Day, All-Week Protection



Jerry Rea, plant worker, checks on the trouble-free operation of twin towers comprising Kemp Model 50-S Oried Dryer.

Sulphur Producer Gets Automatic Drying of Compressed Air with Kemp

During their processing of sulphur and sweetening of natural gas, the Powell, Wyoming, plant of Seaboard Oil Company of Delaware needs large quantities of dried, compressed air to operate complex control instruments.

When their Silvertip Field plant was opened, the operators turned to Kemp to provide this dried air, installing a Model 50-S Kemp Dryer. The machine operates on a manual switching and automatic timing device. Imbedded steam coils reactivate the towers . . . permitting 25 cfm capacity at an exit pressure of 50 psi. The installation is operating 24 hours a day on a seven-day week — preventing corrosion and avoiding costly delays caused by line freezes in the plant.

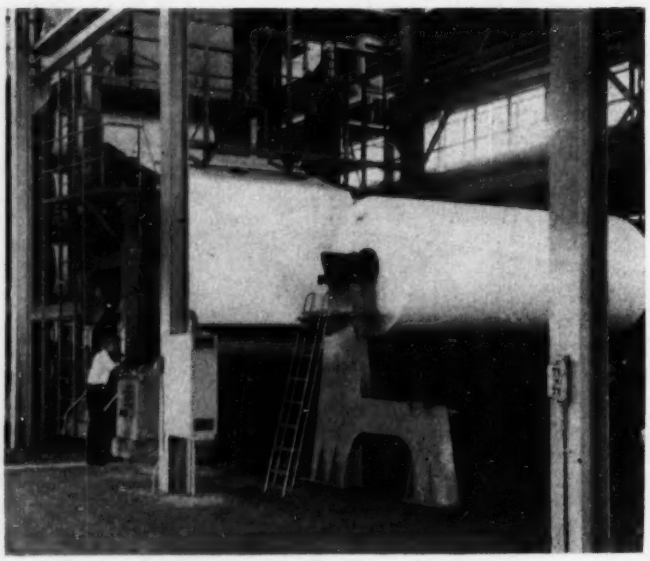
If drying air or other gases is a problem in your operation, it will pay you to discuss your problems with a Kemp Engineer. He can recommend specific equipment to handle your specific problem . . . and give you the benefits of *every* Kemp installation—simplicity of operation and maintenance, low installation cost and minimum maintenance expense. A Kemp Engineer is ready to discuss your needs—without obligation.

For detailed, technical information, ask for Bulletin No. D-29. Write to:
C. M. KEMP MFG. CO., 405 E. Oliver Street, Baltimore 2, Maryland

KEMP OF BALTIMORE

ADSORPTIVE DRYERS

ATMOSPHERE & INERT GAS GENERATORS
SINGEING EQUIPMENT • IMMERSION MELTING POTS
CARBURETORS • BURNERS • FIRE CHECKS



Brand New Process Makes Premium Cellulose

New in two important areas, digestion and bleaching, Rayonier's latest chemical cellulose plant (Jesup, Ga.) is now in full operation. Annual output is expected to approach 100,000 tons a year of high purity cellulose (above) for use in making high tenacity rayon.

The over-all process seems to combine some of the best features of sulfite, sulfate and Kraft processes, but is actually none of these. Closely-controlled digestion, which can operate over a very wide pH range (2-12), differs mostly in the choice of operating conditions. Bleaching is carried out continuously in a six-stage unit that uses chlorine dioxide in two steps.

Investment cost for the Jesup plant was about $23 million. This compares with much higher investments per ton of capacity for earlier chemical cellulose plants.

No Vacuum Needed for Freeze Concentration

Using a new freeze concentration process that eliminates vacuum treatment, Florida Chemists and Engineers, Inc., have succeeded in making frozen orange juice that tastes better and keeps longer. In a paper presented to the American Chemical Society in St. Petersburg, Fla., James B. Redd and Robert A. Nance described their technique in this way:

"Juice is frozen into a slush and passed through a separator. High ester juice (high in flavor compounds), having approximately 30% natural flavor solids, is first removed from the separator. Secondly, the ice crystals, which trap approximately 5% of the solids, are removed.

"The ice is melted and concentrated through standard low temperature evaporators (flash heated to 165-170 F. for 6-8 seconds). This yields concentrate which is blended with the 30% juice to give the desired citrus concentrate. This concentrate contains much more of the flavoring esters than standard citrus concentrates."

Pectin-splitting enzymes are normally responsible for poor storage characteristics. The new process permanently inactivates these in the flash heating step.

News Briefs

Butadiene: A fast tax write-off for 60% of a $2.3 million investment has been awarded to Union Carbide & Carbon Corp. for a butadiene plant at Seadrift, Tex. The certificate was first filed in August 1952, but was denied at that time.

Silicones: Dow-Corning Corp. is setting up a joint company with Sumitomo Chemical Co. in Japan to make silicone products.

Hydrogen Peroxide: The first substantial reduction in the price of hydrogen peroxide since before World War II has been made by Buffalo Electro-Chemical Co. Amounting to slightly over 6% for tankcar quantities, the cut covers 27.5%, 35%, 50% and 90% peroxide concentrations.

Terylene: Imperial Chemical Industries of Canada expects to have its $20 million terylene plant at Millhaven, Ont., in full production this month. It's Canada's first.

Teflon: Du Pont will double its present capacity for making Teflon—tetrafluorethylene resin—at its Washington works near Parkersburg, W. Va.

Styrene Oxide: A 25% price reduction (from 95¢ to 70¢ per lb.) is now in effect for Dow Chemical Co.'s styrene oxide. This product is used mostly as a reactive diluent in epoxy resins and in synthesizing aromatics.

Rubber Chemicals: A new rubber chemical accelerator plant which more than doubles present capacity has been opened by American Cyanamid Co. at Bound Brook, N. J.

Bisphenol A: Dow Chemical Co. has doubled its capacity for bisphenol A. Most of the output from a new plant just completed at Midland, Mich., will go into making epoxy resins.

The BECKMAN

Ultraviolet—Near-Infrared Quartz Recording

SPECTROPHOTOMETER

The Beckman Model DK Spectrophotometer is the first commercially-available instrument designed specifically for the near-infrared region of the spectrum—filling an important gap in spectrochemical analysis. Its lead sulfide detector and quartz monochromator permit high-speed transmittance recording at cost and performance unmatched by conventional infrared instruments. Using a photomultiplier detector for ultraviolet work, the Model DK offers a guaranteed wavelength range of 220 to 2700 mμ—wider than that of comparable spectrophotometers twice the price.

The DK's "double-beam ratio" principle is a unique system for percent transmittance recording. (1) It provides the stability of double beam operation, with a single receiver. (2) The fast beam chopping (480 times per second) takes full advantage of the sensitive lead sulfide detector.

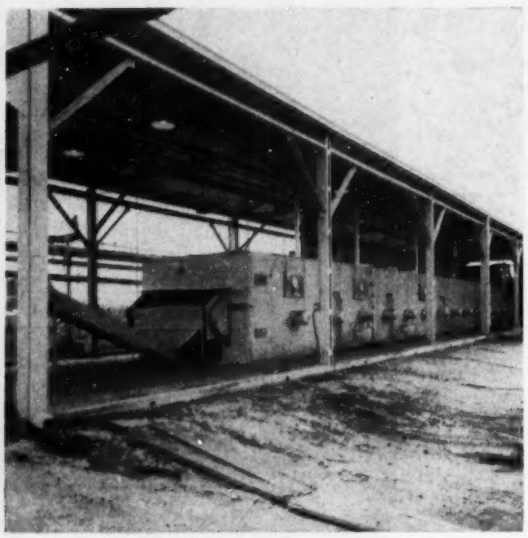
Resolution	0.1 mμ at 220 mμ; 2.5 mμ at 1000 mμ; 5 mμ at 2500 mμ—higher than any other instrument in its price range.
Scanning Speeds	For the entire 220 to 2700 mμ range, any of 5 speeds is selectable: 5, 15, 50, 150 or 500 minutes. At highest speed, the near-infrared is traversed in one minute, while very low speeds are available for extreme resolution.
Stray Light	Less than 0.2 percent 0.2 – 2.5μ
Recording Features	Ozalid-reproducible paper...adhesive strips for easy wavelength reference...chart speeds of ½, 1 and 2 inches per minute...

For additional information write for data file No. 98-14

Beckman *division*

BECKMAN INSTRUMENTS, INC.
FULLERTON 1, CALIFORNIA

SOURCE: Lignin is found in waste pulp-cooking liquor.



USE: Lignin-reinforced rubber moves through dryer.

Lignin: Perpetual Source of Chemicals

Wood pulpers have lignin coming out of their ears. They dump or burn most of it. But there's plenty of of reason to believe this byproduct deserves a better fate.

In the chemical pulping of wood tremendous quantities of lignin—25-30% of all wood is lignin—are unavoidably produced as a by-product. Last year nearly 10 million tons of lignin, leaving the pulping processes in spent cooking liquors, were either dumped into the nearest stream or burned for fuel.

▶ **Change of Heart**—Three developments are causing the paper industry to regard lignin with new interest and respect, however: stream pollution problems; sharpening insight into this complex substance's inner workings; and the growing industrial emphasis on squeezing raw materials dry of dividends and throwing nothing away without wincing.

Running pulp mill sulfite waste liquors into rivers means quick disposal but it also makes big demands on the water's oxygen content. Alkaline pulpers do not have as serious a problem because of the lower carbohydrate content of their wastes and the favorable economics of burning liquor concentrates for fuel and to recover valuable chemicals.

Research into the character of lignin has been both a cause and effect of quickening interest in the chemical. Although the exact structure of lignin still is not known, its components have been pretty well identified. Just how they are put together remains the poser.

Lignin now costs 6-8¢ a lb. Mass produced, it could easily sell for less than a nickel—a mighty attractive price for many applications. Mix this price with a potential supply of 10 million tons of lignin a year, spice with a little arithmetic and you have a juicy billion dollar pie to set before the pulp and paper industry. Surely it rates more than a nibble.

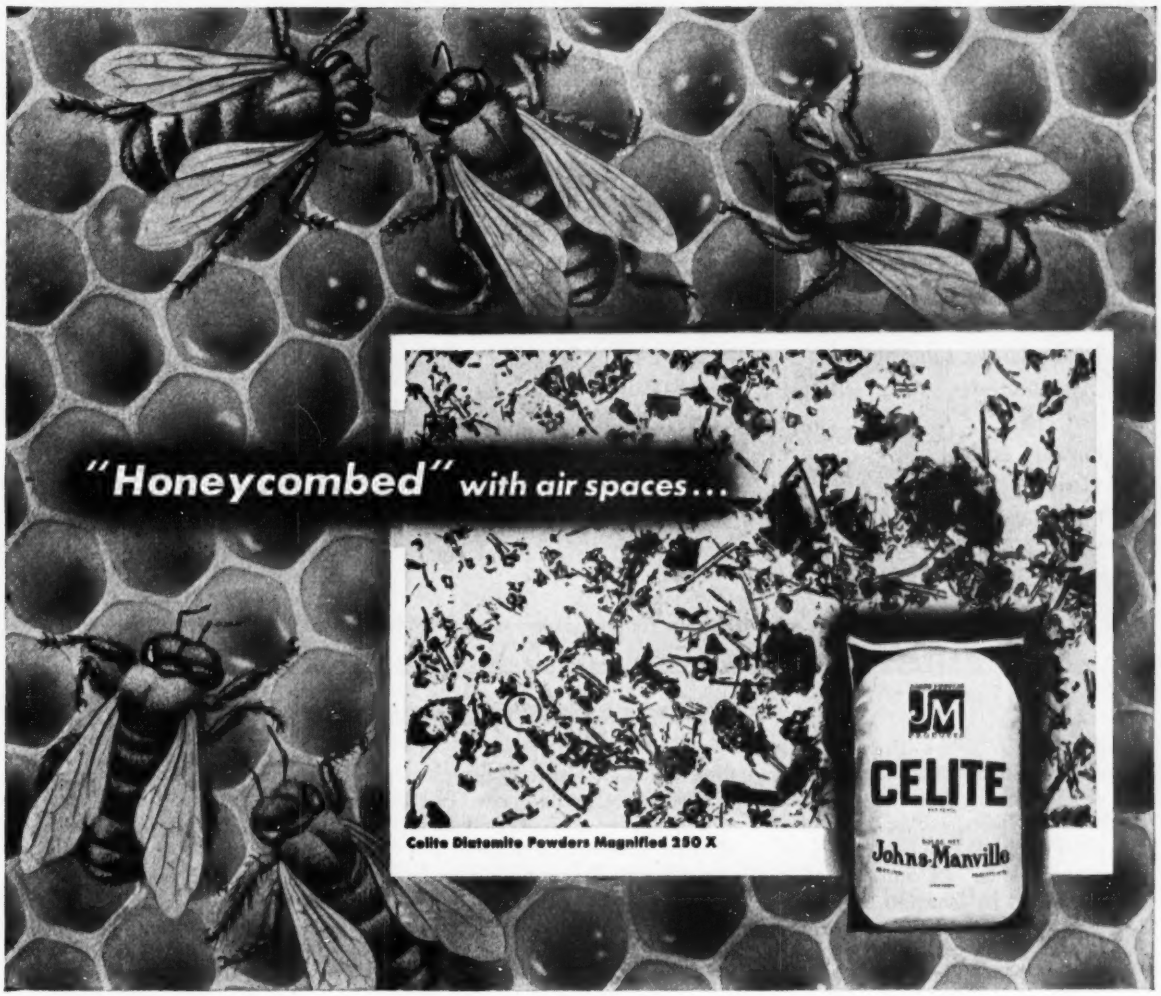
▶ **What Can Be Done**—Three roads to lignin utilization lie ahead, the first of which is starting to bear heavy traffic.

- Use of whole lignin, its salts and lignosulfonates as they are recovered from pulp liquors without further processing except for purification.
- Unit processing of lignin—chlorination, sulfonation, esterification, etc.—to produce useful derivatives.
- Controlled, systematic breakdown of whole lignin into lower molecular weight organic materials.

The first course, utilization of naturally occurring lignins, has been investigated the most and promises the quickest payoff in the near future simply because you don't always have to know what something is as long as you know what it can do for you.

Let's look at lignin's industrial uses.

▶ **Rubber Reinforcement**—Most



Celite Powders provide bulking action

3 to 10 times greater than any other inert mineral filler

POUND FOR POUND, Celite* diatomite powders supply more bulking action than any other inert mineral filler because their cubic volume is 3 to 10 times greater. Celite's unique "honeycombed" structure is composed of microscopic, irregularly shaped particles that won't pack down. In mass they weigh only about 10 lbs. per cubic foot.

That's why Celite is so widely used to add bulk and body to industrial formulations. For example, it extends white pigments in paints and papers . . . it improves dispersion of insecticides and fertilizers . . . it fluffs up dry powders such as household cleansers.

Also, from Celite's "honeycombed" structure comes its great absorptive capacity. This characteristic is profitably utilized to keep powders free-flowing . . . to provide a medium for shipping or storing liquids in dry form. And because of the physical structure of its individual particles, Celite has become the outstanding flatting agent for paints . . . it serves as a mild, non-scratching abrasive for fine polishes . . . it improves the surface appearance of plastics.

Which of the many Celite advantages can you use to build product performance or cut costs? A Johns-Manville Celite Engineer will gladly discuss your problem, without obligation. For his services or more information, write Johns-Manville, Box 60, New York 16, New York. In Canada, 199 Bay St., Toronto 1, Ontario.

*Celite is Johns-Manville's registered Trade Mark for its diatomaceous silica products.

JOHNS-MANVILLE JM PRODUCTS **Johns-Manville CELITE** INDUSTRY'S MOST VERSATILE MINERAL FILLER

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. . . For more about any item, use Reader Service postcard (p. 465)

rubber compounds contain 25-30% of a reinforcing pigment which imparts toughness, wear resistance and other properties not possessed by rubber alone. In an application considered by many to be its biggest potential, lignin is dissolved in rubber latex (natural, GR-S, neoprene, nitrile), coprecipitated with the rubber by the usual acid coagulation and serves as a reinforcing agent akin to carbon black and mineral pigments.

Lignin-reinforced rubber's unusual qualities point to the wood chemical as a potentially valuable addition to pigments in use today. Its specific gravity, lower than that for other pigments, means a lighter weight rubber. Its opacifying power, lower than black reinforcers, permits lighter colors at no sacrifice to strength. At high loadings lignin yields an extremely tough compound with high tensile and tear strengths, elongation and hardness.

Not all of lignin's properties are superior to those of other fillers but its low cost and high reinforcing ability are not easy to shrug off.

▶ **Commercial Operations**—West Virginia Pulp and Paper is producing lignin-GR-S coprecipitates at its Charleston, S. C. lignin plant in quantities large enough (10-15 tons a day) for extended evaluation of both product and process. For this operation rubber latex must be brought in by tank car. In the long run, however, the logical place to make coprecipitates would be in synthetic rubber plants where shipment of latex with its high water content can be avoided. And, with rubber formulations so complicated, the compounders themselves are best qualified to explore all possibilities for lignin-reinforced rubber.

▶ **Asphalt Emulsion Stabilization**—Probably lignin's top commercial outlet at present is as a stabilizer for oil in water type, slow break asphalt emulsions where soaps are primary emulsifiers. Lignin prevents emulsion breaking reactions between soaps and calcium-bearing substances like road paving aggregates. Lignin's low ash content gives it an edge over inorganic stabilizers.

▶ **Ceramic Binders and Deflocculants**—As a deflocculant or dispersing agent, lignin maintains fluidity for shaping ceramic pieces with a minimum of water. It introduces little sodium, an advantage over inorganic deflocculants.

As a binder, lignin greatly strengthens dried but unfired bodies, prevents breakage at this point. Organic in nature, lignin burns out during firing without affecting color or other properties of the finished piece.

▶ **Dry Levelers and Dispersants**—In the dyeing of cotton and regenerated cellulosic textiles with vat and sulfur dyes the trick is to secure uniform, or level, coloring of the goods. Lignin compares favorably with other leveling agents in retarding the rate of dye adsorption and insuring uniform dyeing.

Large amounts of lignin are used as a dispersant for acetate rayon dyes which are insoluble in water and which dye by forming a solid solution with the acetate fiber. By dispersing large dye particles and preventing subsequent agglomeration, lignin helps secure uniform coloring.

▶ **Oil Mud Additives**—Lignin solutions reduce oil drilling mud viscosities and gel points. They have, by virtue of their colloidal nature, excellent sealing action on the bore wall and form barriers impervious to water but removable by oil.

▶ **Protein Precipitation**—Lignin re-

This article is based in part on a recent paper by Dr. Paul W. Wiley, Manager, Polychemicals Division, West Virginia Pulp and Paper Co., Charleston, S. C.

HCOOH

Points the way to better quality in many products . . .

Heyden Formic Acid possesses a combination of properties which make it the preferred acid for many industrial applications:

- VOLATILITY—elimination of acid residues, which may damage materials being processed, is simplified by the volatility of formic acid.
- SOLUBILITY—readily soluble in water, alcohol and ether.
- HIGH PURITY—careful supervision and technical control produce an exceptionally pure, uniform acid in 85% and 90% concentrations.
- HIGH IONIZATION CONSTANT—2.14×10^{-4}—one of the strongest organic acids (approximately 12 times as strong as acetic acid). Permits efficient adjustment of pH over wide range.
- LOW MOLECULAR WEIGHT—46.03—smaller amounts of acid are required for neutralization, resulting in economies.

Heyden Formic Acid can be advantageously employed in the dyeing and finishing of textiles, the tanning and dyeing of leathers, for coagulating rubber, for organic syntheses, and as a raw material for the manufacture of drugs, odorants, fumigants, catalysts, plasticizers and water-proofing compounds.

Shipped in 525 lb. stainless steel drums and 125 lb. carboys.

•

Heyden SODIUM FORMATE—a high quality, uniform product extensively used in tanning leather, making water-resistant wallpaper, and in dyeing and finishing of textiles. Shipped in 50 lb. multiwall paper bags.

•

Have you received your copy of our technical bulletin on Formic Acid? If not, send for it today.

HEYDEN CHEMICAL CORPORATION

FINE HEYDEN CHEMICALS

acts with proteins in aqueous mediums to form coagulates removable by filtration. This is the basis of a number of separation, purification and recovery processes, especially in the food and drug field.

▶ **Plastics Extenders**–Because of its phenolic groups, lignin is a good extender or replacement for phenols in the preparation of phenol-formaldehyde resins. Lignin can be substituted for up to 50% of the phenols used without adversely affecting quality.

▶ **Sodium Lignate**–Lignin's sodium salt is easily recovered from alkaline pulping liquors (and may be later acidulated to yield lignin). Sodium lignate may be used in place of lignin where water solubility (lignin is soluble in alkalis only) is an advantage: asphalt emulsions, ceramic dispersion, protein precipitation, etc. It's water solubility and inorganic content would be liabilities, however, in rubber reinforcement and ceramic binding, respectively.

▶ **Lignosulfonates**–In the acid sulfite pulping process lignin is converted to soluble lignin sulfonic acid and is recoverable as various salts or lignosulfonates. These salts have a number of uses: conversion to vanillin–an old but limited outlet, volumewise; as dispersing agents in concrete, pigment mixes, carbon black rubber masterbatches; as extenders for more expensive tanning agents such as quebracho; as viscosity controllers in water base oil drilling muds; as agents in ore flotation.

Sometimes lignosulfonates are not isolated and the whole waste liquor is instead used in several ways: as a road binder for dirt roads; in yards to lay dust; in the compounding of adhesives, especially for floor coverings; as a core binder in foundries.

▶ **Derivatives**–Although whole lignin can be converted to a number of derivatives by simple chemical reactions, little work has been done aimed at commercial production. Sulfonation of lignin to produce lignosulfonates has gathered momentum but products of chlorination and other unit processes are still under study.

▶ **Degradation Products**–The surface of this subject–commercial production of organic chemicals by systematic breakdown of lignin into its components–has been scarcely scratched. However, many lignin degradations are known experimentally.

• Oxidation yields a large number of benzene derivatives.

• Hydrogenation gives derivatives of cyclohexane.

• Other reactions produce a wide variety of phenols, acids, alcohols and hydrocarbons.

Many of these chemicals are obtainable from coal in which case lignin would be hard pressed as a competitive source. But some of them are much more unique.

▶ **Provocative Prospects**–Most lignin degradations performed in structural studies have been pretty drastic, resulting in fragmentary products of relatively low molecular weights and based on a single benzene ring. The inevitable question: Can a carefully controlled, milder degradation split lignin into fairly large pieces and thus give rise to a new series of chemicals of intermediate molecular weight?

No wonder paper men are giving lignin a close, hard look. This old "nuisance"–so abundant and so cheap–may be their No. 2 asset.

144A

Packaging Tape

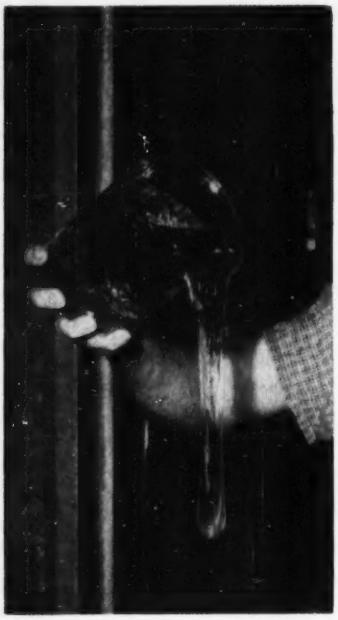
Water-resistant, paper backed, pressure-sensitive tape seals packages, protects merchandise.

Paper-backed, of high strength, and specially impregnated with a water proof rubber resin, P 17 tape is designed to withstand rough handling in shipment under wet and dry conditions. Unlike gummed tape, self-striking P 17 needs no activating solvent, permitting faster and cleaner application.

Although intended primarily for carton sealing, P 17 has other uses: heavy-duty splicing of paper board and parchments; protection of polished or machined surfaces against shipping or processing damage.–**Permacel Tape Corp., New Brunswick, N. J.** 148A

For More Information . . .

about any item in this department, circle its code number on the Reader Service Postcard inside the back cover.



C-Oil

Petrochemical will reduce paint makers' dependence on agricultural oils.

A heavy bodied, sticky, almost colorless liquid (see cut), based on butadiene, promises to make possible better surface coatings.

• Enamels and varnishes have lasting, smooth, hard, mirror-like gloss, permit easy removal of stains and smudges. Neutral colored varnishes bring out natural grain of wood products.

• C-Oil masonry paints are excellent for covering concrete playroom floors. Coatings stand up well for 2-3 years, particularly on rough patches of concrete where other paints tend to wear.

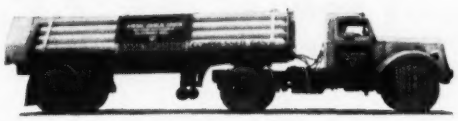
• C-Oil primers bond tightly to metal surfaces (believed 2-3

BORON FLUORIDE —*Versatile Catalyst*

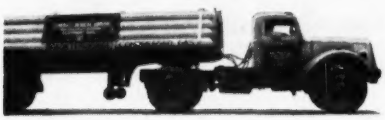
BF_3

The Process Industries Made it *Important*—

B&A Makes It *Available*—

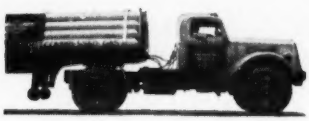


For Petroleum



Phenol Alkylates

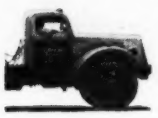
Synthetic Rubber



Resins

Solvents

Non-Ionic Detergents



Plastics

THE VERSATILITY of Baker & Adamson Boron Fluoride has rapidly made it a major catalyst in the process industries. Boron Fluoride's increasingly wide range of applications and its cost-cutting production advantages—such as its ability to decrease sludge formation in many operations—make it a truly "all-round" catalyst. Shown below are some of the important reactions "carried through" by Boron Fluoride and the advantages it can bring to *your* processes.

FIRST to introduce Boron Fluoride Etherate to industry, and a pioneer in shipping the compressed gas by tank transport, Baker & Adamson has long been a leader in the research and production of fluorine compounds. Today, a fleet of large trailer trucks answers industry's need for Boron Fluoride . . . and B&A maintains warehouses from coast to coast where 62 lb. cylinders of the gas can be stocked on request.

FOR SPECIAL applications, the complexes of Boron Fluoride offer more economical and even "delayed action" catalysis. B&A produces Boron Fluoride complexes with ether, phenol, ammonia, monoethylamine and other nitrogen bases. Send for free information today!

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For Alkylation
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And Gain These Important Advantages:

- Wider operating temperature ranges
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- Improved properties of end products
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- Fewer undesirable waste materials
- Greater catalytic activity from smaller quantities
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times tighter than previous products). Base coats for autos, prefabricated wall panels and office furniture are potential applications.

• Surface coatings based on C-Oil strongly resist scratching even after submersion for 5 yr. in a harsh chemical solvent, and stand up well to alkalies, dilute acids and water.

Use of C-Oil as a base for industrial coatings will lend impetus to the trend away from natural paint raw materials by easing paint makers' dependence on linseed, soya, tung and other agricultural oils which vary in price and supply.

And the Glidden Co., licensed to develop C-Oil surface coatings, anticipates better quality control than is possible with present oils.–**Standard Oil Development Co., New York 19, N. Y.** 148B

Dry-Film Lubricants

Epoxy-based dispersions of graphite and molybdenum disulfide afford corrosion resistance and lubrication.

Two products offering advantages of epoxy resins as a base for dry lubricating coatings are 'dag' Dispersion No. 213–containing colloidal graphite–and 'dag' Dispersion No. 223–containing molybdenum disulfide.

Films formed with these dispersions show excellent adhesion and wear resistance, are unaffected by oils and solvents and can be used wherever temperatures do not go above 500 F. All types of surfaces, whether or not pretreated by chemical or mechanical means, can be coated with films imparting corrosion resistance as well as lubricating effect.

Typical uses: dry lubricating films for high-temperature screw threads, precision gears, bearings, shafts, etc.–**Acheson Colloids Co., Port Huron, Mich.** 150B

Surfactant

Possesses long lasting stability, broad solubility, good detergency.

Petro AA, an alkyl aryl sodium sulfonate, is soluble and stable in water, polar organic solvents, most acids, alkalies, alkaline salt solutions, and solutions of copper, iron, mercury manganese, calcium, etc. And it gives marked reductions in surface tension of water, acids and alkalis.

Petro AA, available in powder or liquor form, is used in the following:

• Chemical Reactions–surface tension lowering acts as catalyst. Example: superphosphate production.

• Textiles–Petro AA acts as a wetting, penetrating and dye carrying agent; a wetting agent and detergent in scouring, carbonizing, bleaching and rinsing.

• Paper–AA functions at any pH, temperature and pressure to promote rapid disintegration of chips in pulping processes and caustic cooking of rags.

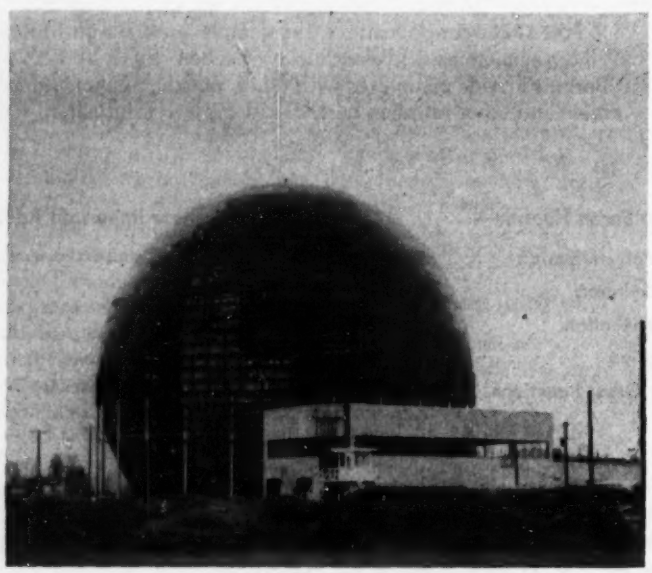
• Pigments–improves ease and degree of pigment dispersion without affecting character of finished product. Burnt umber, ultramarine blue, carbon black and chrome yellow medium are typical pigments, the wetting of which is improved by small amounts of Petro AA.

• Viscosity Reduction–in detergent slurries prior to spray or drum drying.

• Petroleum – water flooding, oil well acidizing, fluidizing drilling mud.

• Rubber–Petro AA is a wetting and grinding agent for pigments, sulfur, and in latex emulsions.

• Pickling Baths – Petro AA



Huge Hortonsphere Will House Atomic Sub Tests

Photo shows world's biggest Hortonsphere–225 ft. in diameter–being built near Schenectady, N. Y. In this giant ball Knolls Atomic Power Laboratory (operated by General Electric for the Atomic Energy Commission) will put a prototype atomic powered submarine through its paces. The sphere's steel surface is coated first with Insul-Mastic, a reinforced asphaltic coating, then with cellular glass insulation, and finally with a vapor and weather barrier of Insul-Mastic membraned with glass cloth. Insul-Mastic Corp. of America, Pittsburgh, Pa. 150A

New!

Announcing

SOLVAY® *Mercury Cell* CAUSTIC POTASH

New!

A New Standard for Premium Grade Caustic Potash

New Standard! Low Chloride

New Standard! Low Metals

New Standard! Chlorate-free

New Standard! Whiteness

Now for the first time—a reagent grade of caustic potash at a *price no higher than ordinary premium grade* low chloride material.

SOLVAY *mercury cell* Caustic Potash has only *trace quantities* of chloride or metals and chlorates are not detectable. This new material is produced in 2 forms: in pure white flakes, 90-92% and liquid 45%.

The flake is packed in 100-lb. and 350-lb. steel drums. The liquid is shipped in tank cars and in 660-lb. returnable steel drums.

Write today for prices, samples, technical information. SOLVAY's Technical Grade of Caustic Potash will still be available in all standard forms.

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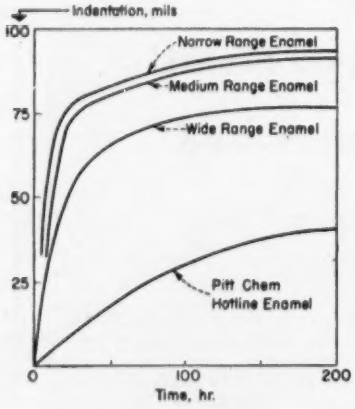
reduces pickling time, decreases acids required, obtains a more uniform pickle, reduces drag-out, drying and rinsing times and inhibits corrosion. 0.1-0.25%, by weight of acid solution, is usually sufficient.

• Alkaline Cleaners—AA lowers surface tension, has good detergency, is very stable; especially useful for alkaline degreasing baths (0.078% Petro AA). AA liquid replaces nonionics in powdered alkali mixes to lay dust and give free-flowing, noncaking compounds.

• Plating Solutions—Concentrations of 0.05-1.0% Petro AA lower surface tension, give even distribution of metal ions and a more uniform plate. Unlike most surfactants, AA obtains maximum reduction of surface tension with lower concentrations, as salt solution temperature rises, and remains stable for prolonged periods at elevated temperatures.—**Petrochemicals Co., Long Beach, Calif.** **150C**



Pipeline Enamel

Protects against high temperatures prevailing on sections of gas transmission lines.

Temperatures as high as 180 F. occur on the pressure side of gas pumping stations — with temperatures of 120 F. 20 mi. from the station. Pitt Chem Hotline Enamel, a tar base coating, is designed specifically to protect pipelines under those conditions without sagging, flow-off and resultant pipe exposure. These qualities, coupled with extreme hardness, give Hotline Enamel high resistance to soil and pressure stresses, to penetration by stones and rough objects, to high ground temperatures anywhere.

The chart shows degree of penetration occurring when Hotline and the three popular enamels are subjected to 5 psi. for 200 hr. at 120 F.—**Pittsburgh Coke & Chemical Co., Pittsburgh, Pa.** **152A**

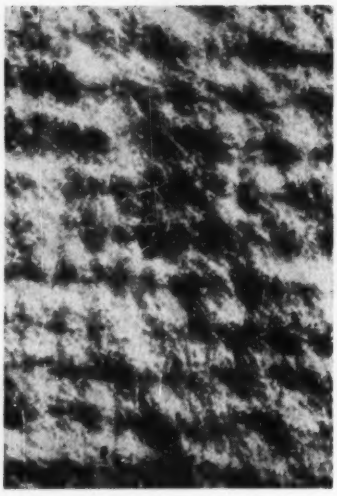
Plastics

Extra high impact polystyrene; glass-filled melamine; molding materials.

• Styron 480, Dow's new super high-impact polystyrene, is claimed 5-10 times tougher than general purpose polystyrene and to have greater elongation. Dow feels 480's premium price (41¢ per lb. compared with 36¢ for high impact grade) will be offset by industry's (particularly toy molders) desire for more durable, "metal-strong" plastic products.

• Melmac 3135 is American Cyanamid's new glass-filled, electrical grade melamine molding material with a heat distortion point in the higher magnitude (200 C. plus). Other properties: high dielectric strength, arc resistance, insulation resistance; low shrinkage and moisture adsorption; good arc-tracking characteristics.

• SMD-3500, RMD-4001, BMG-5000 Brown 15 are new Bakelite molding plastics. SMD, a styrene, flows easily in molding machines to produce parts faster and relatively free from strains and weld lines. RMD, an acrylonitrile styrene, is tough (tensile strength: 11,700 psi.; flex strength: 15,700 psi.) yet can be easily worked and is chemically resistant. BMG, a brown phenolic, has wide molding latitude and faster curing time, maintains critical dimensions at hot temperatures, releases easily from the mold.—**Dow Chemical Co., Midland, Mich.; American Cyanamid Co., New York 20, N. Y.; Bakelite Co., New York 16, N. Y.** **152B**



Filter Felts

Nylon and dacron staple fiber felts make economical, readily fabricated filter media.

Filtaweb Felts, new group of nylon and dacron felts inert to many chemicals, are made from pressed staple fibers. Their dense, non-woven construction makes a uniform, fibrous material (see cut) which retains smaller particles than is possible with most woven cloths.

And since woven filter cloths employ nylon and dacron in the more expensive filament grades, Filtaweb Felts are available at lower cost per square yard. Their pressed structure gives smooth, non-raveling edges without sewing or heat sealing; the felts can be readily cut to size on the job without additional work.—**Brosites Products Corp., New York 7, N. Y.** **152C**

More Strength for Paper

Impregnating method preserves 90% of paper's tensile strength after water soaking.

Many more applications for impregnated paper are possible now where wet strength and abrasion resistance are factors. A new impregnating technique produces a paper which retains 90% of its tensile strength after soaking in water and has more than ten times the abrasion resistance of paper

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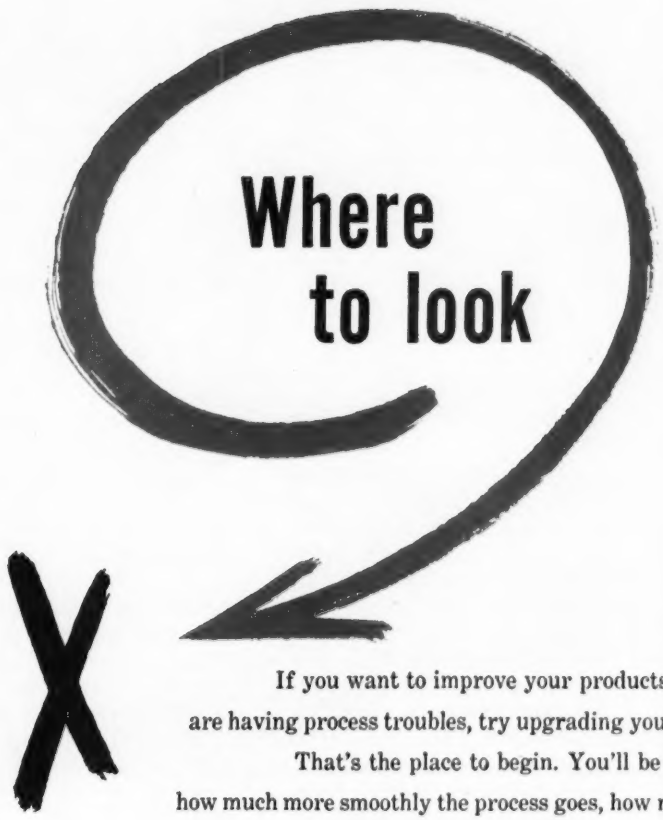
Na	Mg									Al	Si	P	S	Cl	
K	Ca		Cr	Mn	Fe	Co	Ni	Cu	Zn			As		Br	
	Sr							Ag	Cd		Sn	Sb		I	
	Ba		W					Au	Hg		Pb	Bi			



If you want to improve your products – or if you are having process troubles, try upgrading your starting materials. That's the place to begin. You'll be surprised how much more smoothly the process goes, how much more dependable the end result. And – very often – you save in better operation, lower rejection rates, and fewer shutdowns – in addition to maintaining consistently higher quality of products. The leaders in more than 200 process industries served by Mallinckrodt know that Mallinckrodt products are rigidly controlled – precision manufactured to predetermined specifications.

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SERVING THE PROCESS INDUSTRIES

SINCE 1867

Mallinckrodt Chemical Works

Manufacturers of chemicals for industrial, medicinal, photographic and analytical uses

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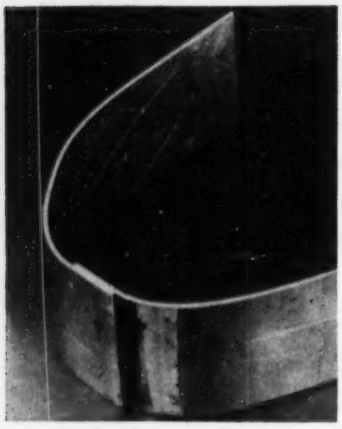
impregnated by ordinary methods.

• Tensile Strength: An impregnated sheet, 0.02 in. thick (with a dry tensile strength of 44 psi.), had a wet strength of 39 psi. after immersion in water for 28 days at 160 F. A 0.03 in. sheet (dry tensile strength of 80 psi.) had a wet strength of 76 psi. after similar treatment.

• Abrasion Resistance: A 0.03 in. thick sheet of stock impregnated by the new method showed little wear after 6000 one pound strokes with a wet hog bristle brush. Stock treated by ordinary methods was worn through after 600 strokes.

The new technique involves use of synthetic resins and elastomers; it can be applied to a variety of paper thicknesses and can be modified to meet various conditions of strength, porosity, flexibility and chemical resistance. – **Dewey and Almy Chemical Co., Cambridge 40, Mass.** **152D**



Structural Adhesives

One has high strength at normal temperatures; the other, flexibility at high temperatures.

Bondmaster M615, for metal-to-plastic adhesion at normal temperatures, yields shear strengths (Air Force Tensile Shear Method) of 3500 psi. with accompanying peel strengths (NEMA method) of up to 19 lb.

Bondmaster M616 joins metal-to-metal, provides shear strengths of 3000 psi. at 180 F. without sacrificing flexibility. Photo shows M616 –bonded strips of aluminum bent in a half circle, yet maintaining 1500 psi. strength after being subjected to temperatures above 300 F.–**Rubber and Asbestos Corp., Bloomfield, N. J.** **154A**

Acetate Yarn

New fiber may broaden acetate market, compete with cotton and synthetics.

X-100, a "modified acetate" yarn, has a higher melting point than conventional acetate, is said to have better launderability–pleats last through seven washings. X-100 has a higher dyeability and lacks the clamminess of some woven synthetic fibers; it can be spun and woven on conventional textile machinery.

The new yarn, it is darkly hinted, could be marketed commercially very soon and at a relatively small outlay of capital. This would indicate a switchover from existing operating facilities to the new product is possible.

X-100 is to be priced competitively with cotton and conventional acetate, is aimed at broadening the acetate fiber market and taking some of the play away from cotton and other synthetics. – **Celanese Corp. of America, Summit, N. J.** **154B**

Product Briefs

Polyester-modified, paper based melamine resin combines good properties of paper based phenolics and melamines. Phenolite Grade Y-2401 has better arc resistance, dielectric strength and mositure resistance than phenolics but, unlike unmodified melamines, is as easy to machine.– **National Vulcanized Fibre Co., Wilmington, Del.** **154C**

Two fatty alcohols, Makanol 8 and 9, claim greater percentages of unsaturation–88 and 91, respectively–than any other commercially available long chain alcohols.–**Stepan Chemical Co., Chicago 6, Ill.** **154D**

A 25¢ a lb. colorless primary plasticizer for polyvinyl chloride and vinyl copolymers is available. A butyl benzyl phthalate, Santicizer 160 reduces costs while adding stain resistance, increasing fusion rates and imparting greater tensile strength.–**Monsanto Chemical Co., St. Louis 4, Mo.** **154E**

Magron, a new cotton defoliant (magnesium chlorate), is being made available for late summer harvesting. A year of field testing has produced favorable results and commercial production has begun. – **Dow Chemical Co., Freeport, Texas.** **154F**

Structural aluminum surfaces are protected against fresh mortar by lacquers based on half-second butyrate, a cellulose polymer. Weather resistance of these lacquers is better, it is claimed, than any other clear, film forming material incorporable in an easily sprayable lacquer. – **Eastman Chemical Products, Inc., Kingsport, Tenn.** **154G**

Chemically resistant clothing made from emulsion-treated Dynel fabric gives protection against splashing chemicals, yet retains porosity, keeps workers comfortable.–**Chem-Wear, Inc., Darien, Conn.** **154H**

Three grades of Aerocat MS fluid cracking catalyst will help petroleum refiners obtain higher efficiencies in these operations: low velocity with good catalyst recovery facilities; moderate to low velocity with average recovery; high velocity with limited recovery.–**American Cyanamid Co., New York 20, N. Y.** **154I**

He makes sure you get Uniformity with Esso

All Esso Petroleum Solvents are made under the most closely controlled modern refining methods. Backed by continuing research and testing, Esso Solvents are famous for their dependable high quality and performance.

6 good reasons why you can depend on Esso Petroleum Solvents

UNIFORMITY — made in modern refineries from carefully selected crude oil sources.

ECONOMY — there's a storage facility near you for low shipping costs and quick delivery.

CONTROLLED EVAPORATION — available in a wide range of evaporation rates with the precise characteristics to meet *your* needs.

SOLVENCY — Esso aliphatics and Solvesso aromatics cover both high and low solvency ranges.

AVAILABILITY — with water terminals in industrial cities, Esso Solvents are always available in bulk.

MODERN HANDLING METHODS — separate tank storage, pumping lines, tank cars and trucks are used throughout all Esso Solvent handling operations.

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Dewey & Almy Chemical Co. installation showing 300 GPH Gaulin Homogenizer used for making resin emulsions, shoe cements and adhesive formulations.

Know How a GAULIN Homogenizer

can improve your emulsions or dispersions

Here's what it's doing for others...

PIGMENT DISPERSIONS
Gives a faster, more uniform suspension with less temperature rise.

WAX OR OILS
Makes a smoother, better appearing product. Stops separation.

LATEX & RESINS
Provides more uniform monomer emulsions. Better polymerization control.

COSMETIC EMULSIONS
Improves texture. Boosts shelf-life. Locks perfume in against evaporation.

GREASES
Improves stability and uniformity or simplifies manufacturing. Improves lubricating value and increases service life.

What can it do for you?

Send us a sample of your product today. Our complete testing facilities will give you the answer — without obligation.

GAULIN PILOT PLANT HOMOGENIZER
Ideal for experimental purposes, operation or process requiring up to 25 gallons per hour capacity. Handles quantities as small as one pint. Available on low rental basis.

GAULIN TWO-STAGE COLLOID MILL
Stator is jacketed for cooling or heating. Gap setting adjustable for .001" to .045". Only 45 seconds clean-up required in changing colors. 12" head room. 12" x 17" floor area.

Gaulin

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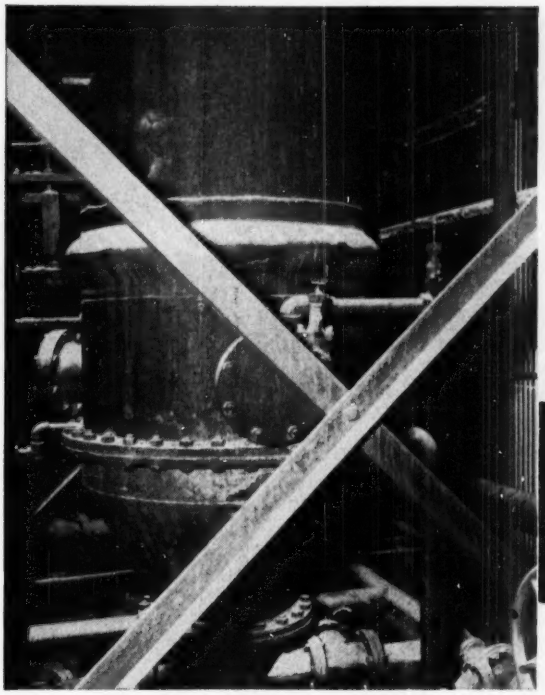
MANUFACTURING COMPANY, INC.
71 GARDEN STREET, EVERETT 49, MASS.
World's largest manufacturer of Homogenizers, Triplex Stainless-Steel High Pressure Pumps, and Colloid Mills



Halifax Paper Company uses

ELECTRUNITE
HEAT EXCHANGER TUBES

This unit is one of seven which make up the company's black liquor evaporator system. And all are in constant use.

That means the tubing must be dependable. It must last long. If it doesn't, frequent replacement can be costly because it interrupts the process.

Halifax uses Republic ELECTRUNITE Heat Exchanger Tubes in its evaporator system. And one reason is Republic quality.

This steel quality is controlled from the time the ore is mined until it becomes a finished tube. Before it's shipped, every length of ELECTRUNITE Tubing must pass rigid tests and conform to or pass all code requirements. It is produced to A.S.T.M. Specification A-214 or to your specifications.

Many Republic customers have benefitted from this quality control for more than twenty-five years. And they've used ELECTRUNITE Tubing in all kinds of processing equipment. Where corrosion is extremely severe, Republic ELECTRUNITE Enduro Stainless Steel Heat Exchanger Tubes are available.

Whether you're interested in new heat exchangers and condensers or re-tubing, you'll want to know about the economies of Republic ELECTRUNITE Pressure Tubes. Write for Booklet HEC-1 for carbon tube and HES-1 for stainless tube.

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first really new *development in safety spectacles in years!*

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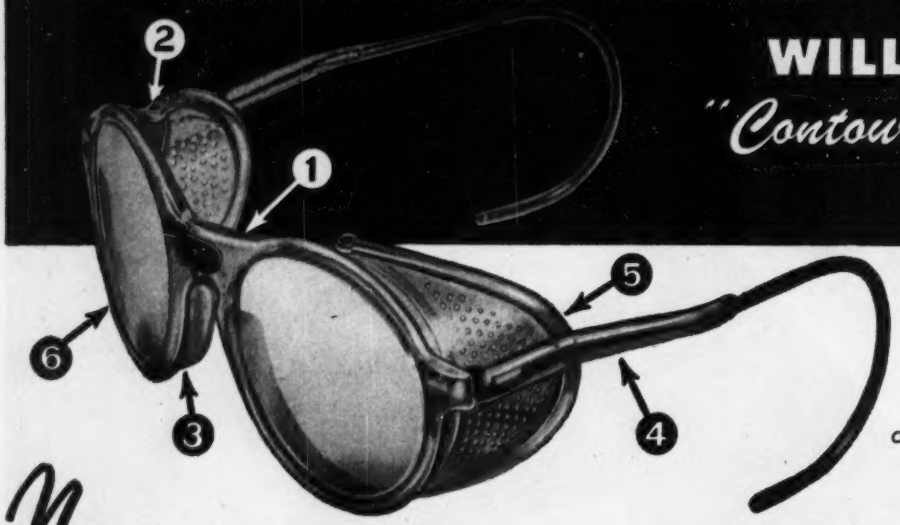


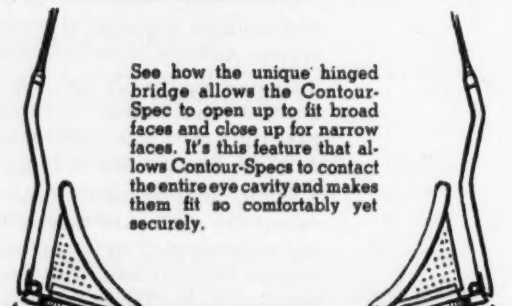
Style WCS47
Covered by Design Patent 168,988

New... hinged bridge gives snug, comfortable fit . . . self-adjusting to *any* facial contour!

1. **New hinged bridge** combines the flexibility of cup-type goggles with the lightweight, compact protection of safety spectacles.
2. **One all-purpose size** permits universal fit. Bridge hinge gives automatic adjustment to any bridge width from 18-26 mm.; one eye size—47 mm.—fits everybody. *No need to stock a variety of bridge and eye sizes.*
3. **Plastic nose-and-cheek pads** provide *full closure* around eye cavity.
4. **Contour-shaped** adjustable plastic-and-cable temples hold spectacles firmly in place.
5. **Matching sideshields** are perforated plastic, providing protection at sides—*fold back* for pocket compactness.
6. **Butyrate frame**—*toughest plastic used for spectacles.* Standard frame is flesh colored, fitted with 6-curve Willson Super-Tough® glass lenses. Available also with green frame and sideshields, fitted with Willsonite® Super-Tough green glass lenses.

Order a supply of Contour-Specs from your Willson distributor. Let your workers try their amazingly greater comfort, and see how they're preferred over ordinary safety spectacles!

Hinged to fit any face snugly!



See how the unique hinged bridge allows the Contour-Spec to open up to fit broad faces and close up for narrow faces. It's this feature that allows Contour-Specs to contact the entire eye cavity and makes them fit so comfortably yet securely.

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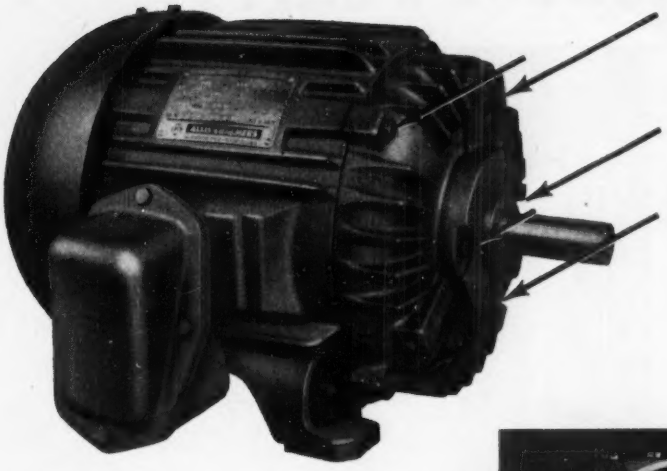

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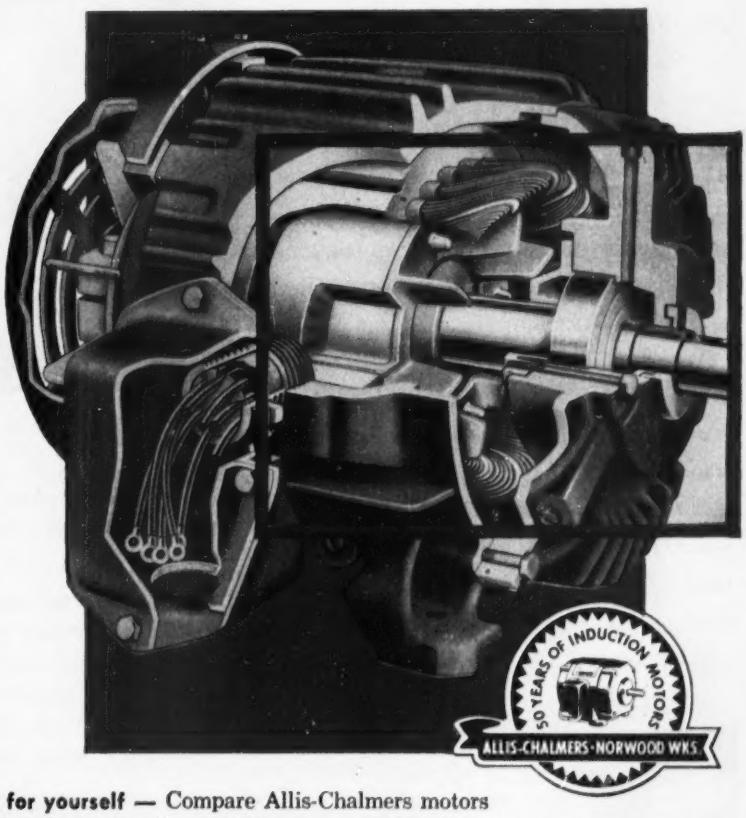
Result? Allis-Chalmers motors pay off in longer, trouble-free bearing life, lower motor maintenance.



Get all the facts . . . judge for yourself — Compare Allis-Chalmers motors with other motors. Get the six-bolt construction that gives you complete bearing protection. For proof, see your Allis-Chalmers Office or Authorized Distributor, or write — Allis-Chalmers, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS

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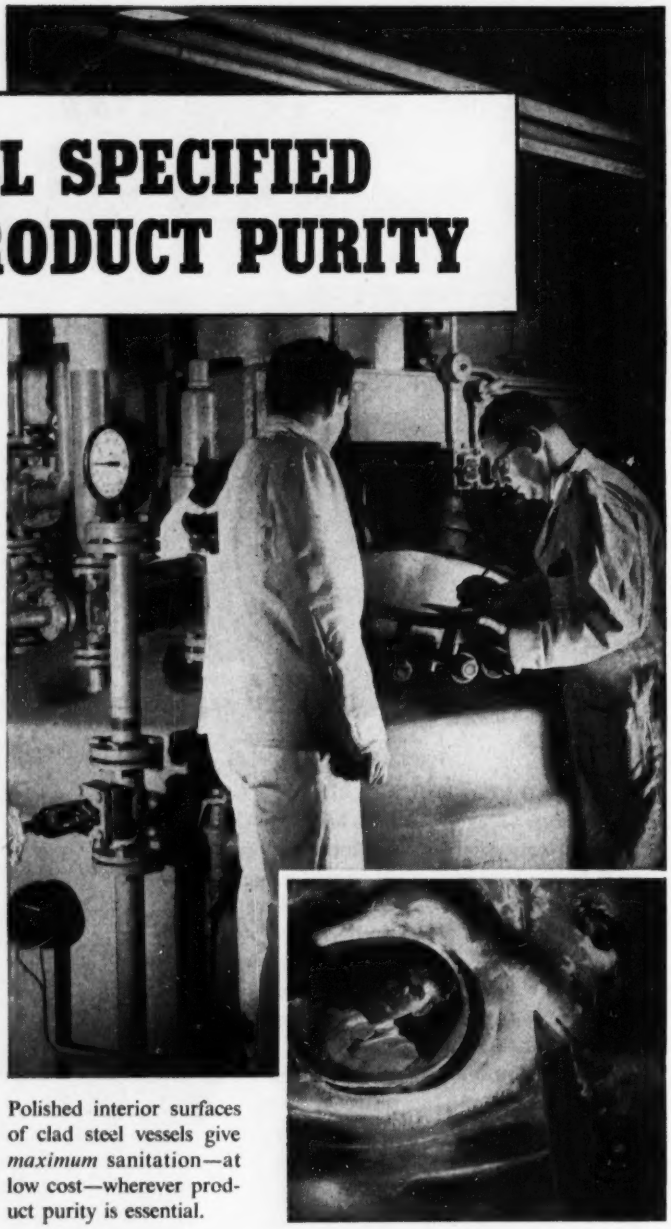

Polished interior surfaces of clad steel vessels give *maximum* sanitation—at low cost—wherever product purity is essential.

Ask one of your fabricators to show you the new Lukens clad steel movie, "Equip for New Profits." Here—in full color and sound—are factual accounts of how clad steel equipment brings new economies. The story can suggest new ideas to everyone concerned with production efficiency. Or contact Manager, Marketing Service, Lukens Steel Company, 678 Lukens Building, Coatesville, Pennsylvania.

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Get in on the ground floor!

The circles on the map represent unclaimed territories for the production of complex fertilizer. The pin locates the only plant presently producing complex fertilizer by a continuous chemical process.

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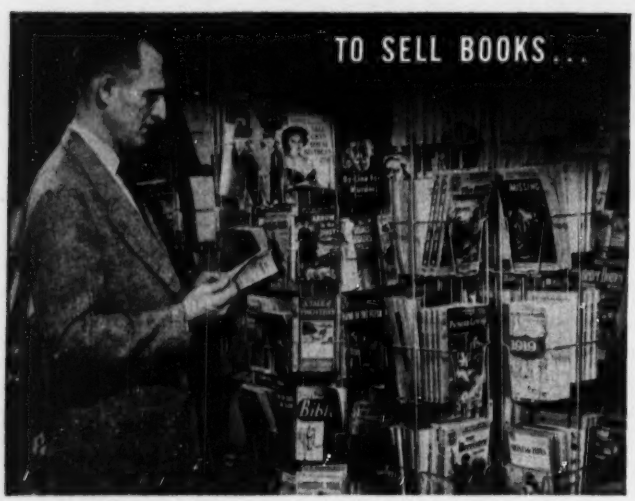

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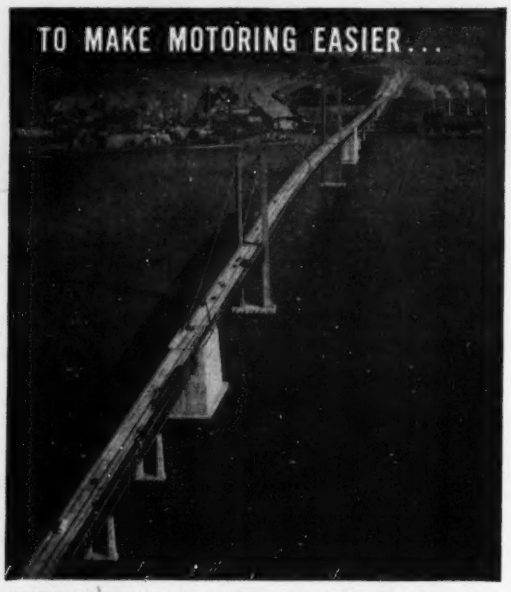

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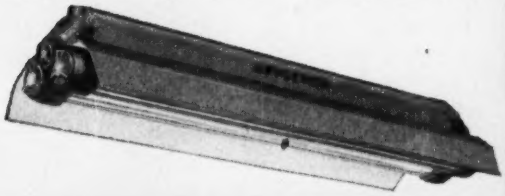
plus quiet, flickerless operation



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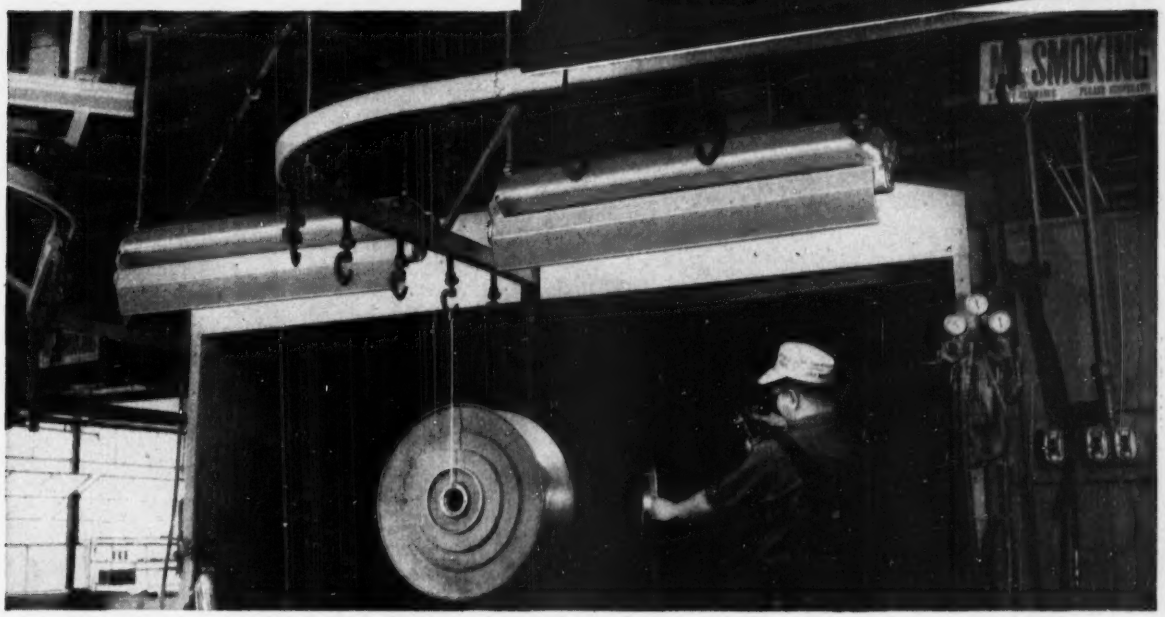

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Complete protection against explosion hazards from lighting equipment is afforded this spray area through the use of APPLETON "EFU" Fixtures. Convenient angle mounting sheds light directly and evenly on the work area. Hazardous locations in refineries, grain mills, color printing plants, chemical plants, pharmaceutical concerns, etc., may be protected in the same manner.

● FOR SAFETY AND SAVINGS, specify *APPLETON "EFU" Explosion-Proof Fluorescent Fixtures and Fittings* . . . a complete quality line from one dependable source. Three different high power factor ballasts are available now, including a new "Rapid Start" for long lamp life, long ballast life without starters, and quiet, flickerless operation. Re-lamping is permitted from either end of fixture, and the APPLETON factory seal eliminates external seals normally required within 18 inches of arcing devices. Whatever the lighting problem, an APPLETON "EFU" installation assures maximum safety, high light output and trouble-free economical service.

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Choice of "Pre-Heat," "Slimline" or new "Rapid Start" ballasts. Designed for use with 40-Watt, 48-inch, T-12, and 85, 90 or 100-Watt, 60-inch, T-17 fluorescent lamps. End housings are cast aluminum with line connections made to a terminal block in the junction chamber.

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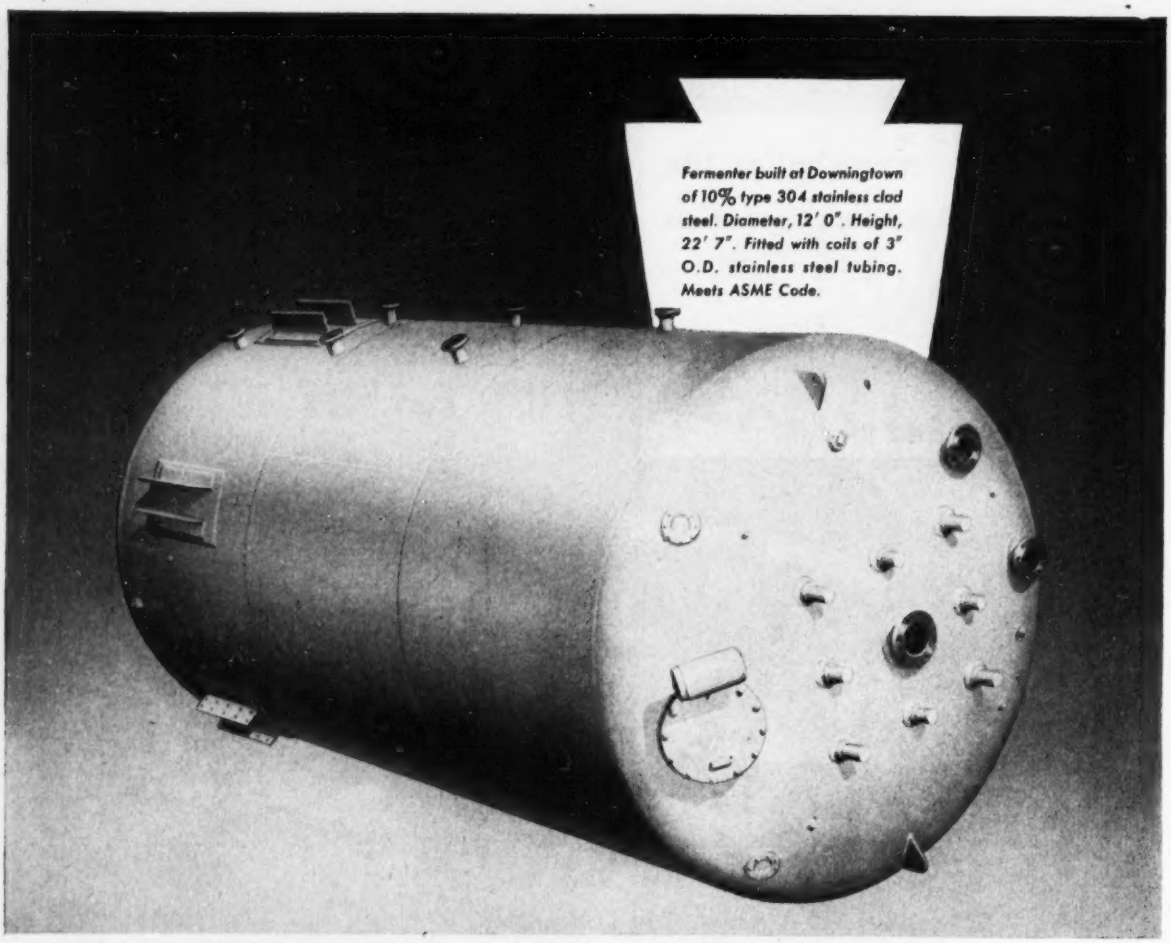
Also Manufacturers of:

Rely on **APPLETON** *. . . The Standard for Better Lighting*



Fermenter built at Downingtown of 10% type 304 stainless clad steel. Diameter, 12' 0". Height, 22' 7". Fitted with coils of 3" O.D. stainless steel tubing. Meets ASME Code.

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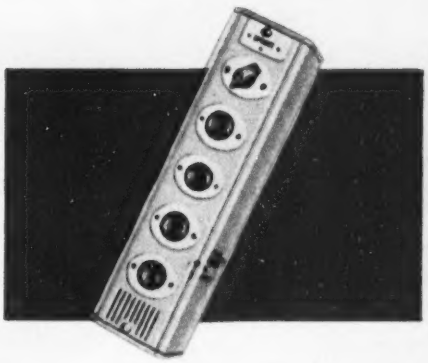

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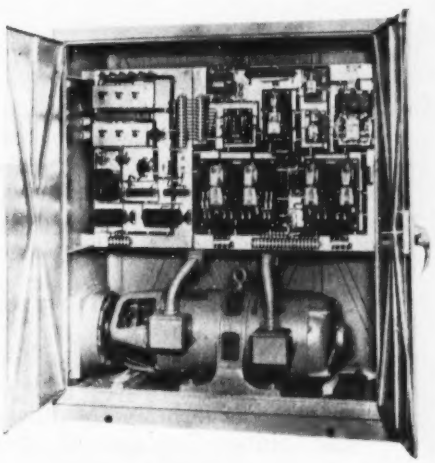
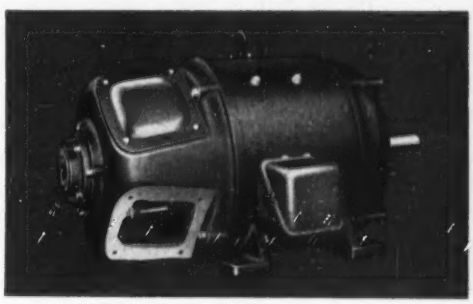


You're welcome to full information on your specific drive problem. Call your nearest Century District Sales Office or Century Authorized Distributor, or write direct. See telephone listings.

Century makes A. C. and D. C. motors 1/8 to 400 H. P.



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So we urge you to let our Ryerson stainless specialists help you select the right type for each particular purpose.

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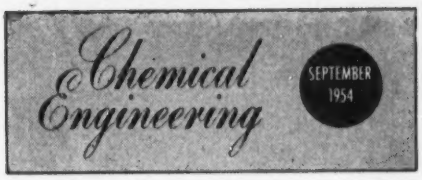


a NEW reference service

Within a few weeks you'll get another copy of *Chemical Engineering*: our 1st Annual Inventory Issue.

This will not be just another monthly issue of CE; it's something new and special, a bonus, a 13th issue to be published only on a yearly basis, an innovation in the chemical publishing field.

So we hope you'll take a close look at it as soon as it reaches you, for we have designed it as a handy reference tool that you can use throughout the coming year —and for years thereafter. It's the type of timely, yet permanent, reference you've asked us for.

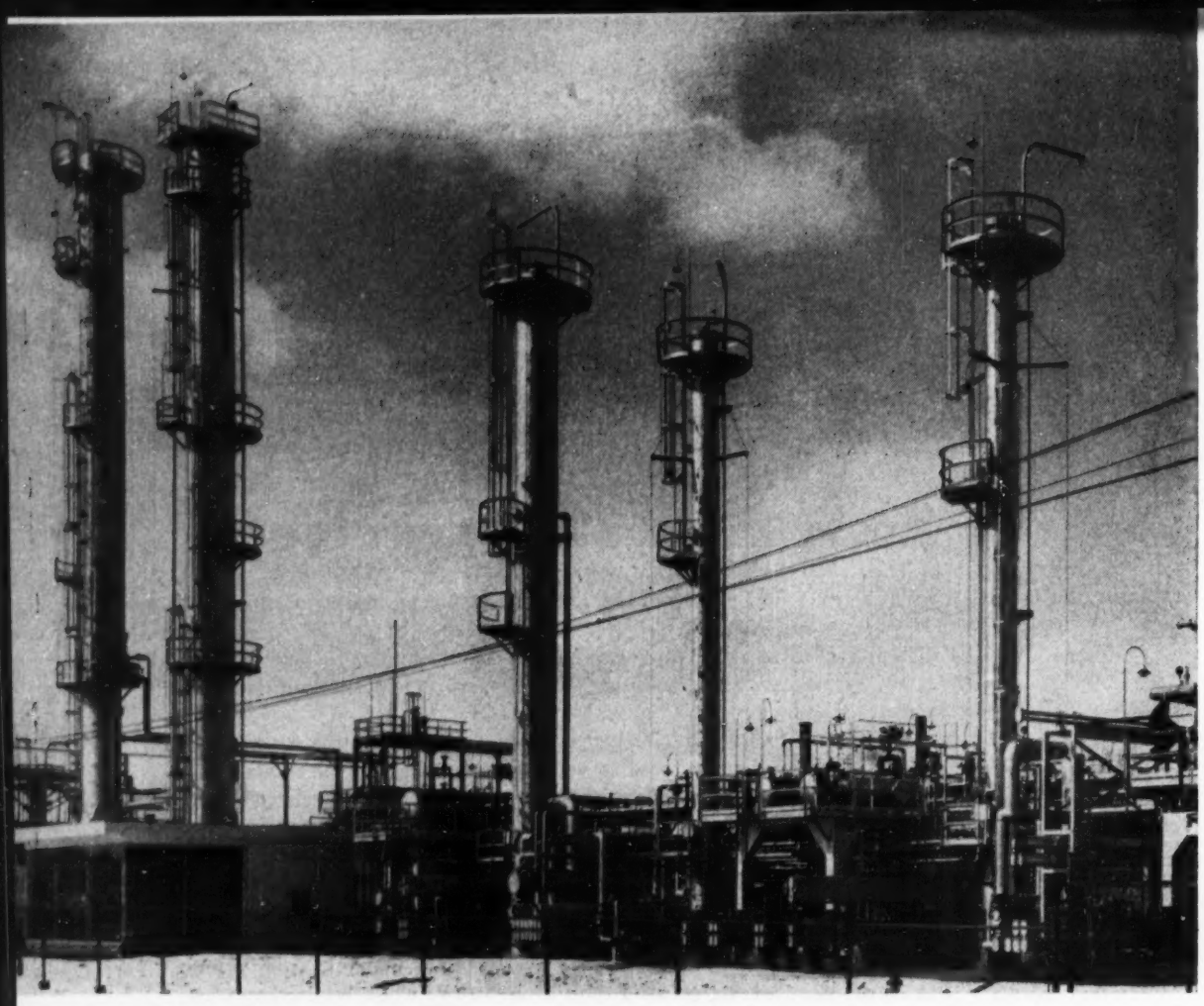
One idea—one objective—dominated all our work on this new Inventory Issue: To bring together and to make available in one place, a comprehensive "inventory" of the most important new and newsworthy developments during the previous twelve months in (1) process equipment, (2) chemicals and materials, (3) plants and facilities, (4) processes and technology, (5) technical literature from manufacturers. In a sense you can say it's a timely rundown of who's been doing what in these five fields during the past year.

But all this reference material isn't worth very much if you can't find what you want—and find it fast. So we've gone out of our way to digest each item down to its factual bone, to organize all items within easy-to-find categories, to develop a format that makes all material easy to scan, easy to find, easy to digest, easy to follow up for more information.

This annual Inventory Issue does not—and cannot—replace our regular monthly issues with their more timely, more detailed and broader reporting of significant developments in all fields of interest to chemical engineers. Instead, it supplements these monthly issues to offer a new type of reference service to chemical engineers everywhere.

Within a few weeks you'll receive your own copy of CE's 1st Annual Inventory Issue. We're confident you'll find it useful as a timely—yet permanent—reference.

John R. Callaham



Binary Distillation

Beginning with familiar fundamentals of two-component separations, this report shows how to apply the more advanced principles and techniques.

AARON J. TELLER

Transformation of the art of distillation into a science—a process still far from complete—can be credited largely to chemical engineers.

Modern distillation practice and the chemical engineering profession both began taking shape towards the end of the nineteenth century. Notable benchmark in distillation theory was publication by the Frenchman Sorel in 1893 of the mathematical theory of rectification of binary mixtures.

Most of us in our undergraduate chemical engineering curricula were exposed to the principles involved in the distillation of binary (two-component) mixtures. Even multicomponent systems often can be analyzed with a fair degree of accuracy by binary mixture procedures, using the method of Hengstebeck.[1]

This report reviews the principles of the behavior of binary systems and the analysis of binary separation problems. Although some of the elementary material will be familiar to many chemical engineers, it leads logically into some new and advanced principles and techniques which need to be better known and more widely applied.

Our first concern is with phase relationships, i.e., vapor-liquid equilibria. Next we see how to apply the principles of fractionation to basic column design problems. Finally, a practical section on equipment design and performance.

(For author biography, see p. 183.)

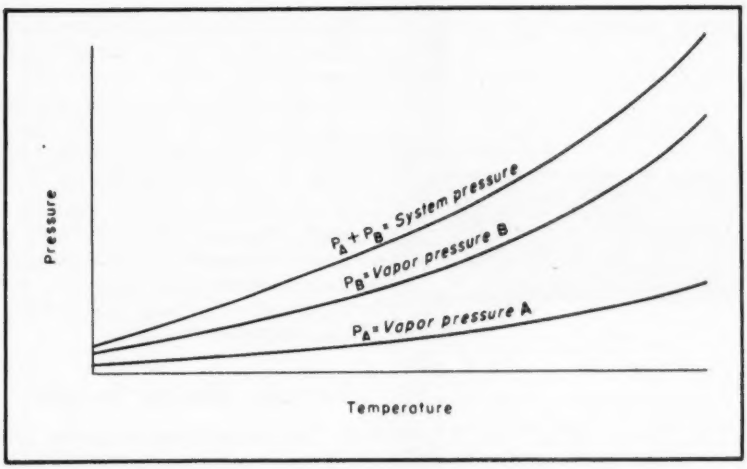


Fig. 1—VAPOR pressure relationships for an immiscible system.

Vapor-Liquid Relationships Are Basic

Here are the best methods for predicting or checking phase equilibrium data for ideal or nonideal systems.

Every liquid substance exhibits a vapor pressure—or escaping tendency—which increases as its temperature goes up.

The term "volatility" usually connotes the ease with which a liquid evaporates or is a measure of its vapor pressure at a given temperature. The lower the temperature at which a liquid boils or the higher its vapor pressure at a given temperature, the more volatile is the liquid. The difference in the volatilities of two substances is the basis of their separation by distillation.

In general, if we heat a mixture of two liquids the more volatile component tends to vaporize to a greater degree than the less volatile component. Thus, the vapor in equilibrium with the liquid mixture contains a higher proportion of the more volatile component than the liquid. The degree of enrichment of the vapor with respect to the more volatile component depends on the relative volatility α of the two substances:

$$\alpha_{AB} = \frac{y_A/x_A}{y_B/x_B} = \frac{y_A x_B}{y_B x_A} \qquad (1)$$

where x = mole fraction in the liquid phase, y = mole fraction in the vapor phase, subscript A denotes the more volatile component and subscript B the less volatile component.

Insofar as volatility relationships are concerned, we recognize four general types of binary liquid systems—completely miscible and normal; completely miscible and azeotropic; partially miscible; immiscible.

Immiscible Systems

Let's look at immiscible systems first (Fig. 1). If we heat a mixture of two immiscible liquids, each will tend to vaporize independently. Their vapor pressures are additive; the system will begin to boil when the summation of the two vapor pressures reaches the total pressure on the system. This point, of course, will be below the boiling point of either of the individual components.

We often take advantage of this phenomenon in steam distillation, where we have an immiscible mixture of water and another liquid. The second liquid might be an organic substance with a high boiling point, yet is heat sensitive. As long as two liquid phases are present, the system will boil below the boiling point of water at system pressure.

How much of each component will be in the vapor? Composition will be in proportion to the relative vapor pressures of the components:

$$\frac{\text{moles } A}{\text{moles } B} = \frac{P_A}{P_B} \qquad (2)$$

$$\frac{\text{weight } A}{\text{weight } B} = \frac{M_A P_A}{M_B P_B} \qquad (3)$$

where P refers to vapor pressure of the pure component and M is molecular weight.

Miscible Systems

Let's return now to miscible systems. The normal miscible system behavior is shown diagrammatically in Fig. 2. Fig. 2(a) is an isobaric equilibrium diagram with coordinates of temperature and composition. The upper curve is the vapor composition, the lower, the liquid composition. If we join the two curves with a horizontal line representing any fixed temperature, the intersections represent the liquid and vapor compositions in equilibrium with each other at that temperature. The vapor is always richer than the liquid in A, the more volatile component.

Fig. 2(b) represents the same system on composition coordinates. Again, y_A is always greater than x_A; that is, the more volatile component is always present in higher concentration in the vapor phase than in the liquid phase.

Such is not the case with azeotropic systems. Here we have a reversal of relative volatility at some composition intermediate between the two pure components. Over one portion of the composition range one component is the more volatile; over the rest of the range, the other component is more volatile.

In the case of the minimum boiling point azeotrope (Fig. 3), addition of the more volatile component A to the mixture lowers the boiling point of the mixture (with A still the more volatile) until the azeotropic point is reached. Here the liquid and vapor both have the same composition, $\alpha_{AB} = 1$, and the boiling point of the mixture is below that of either component. Beyond this point B is the more volatile component.

The reverse situation is true with the maximum boiling point azeotrope (Fig. 4), where the boiling point of

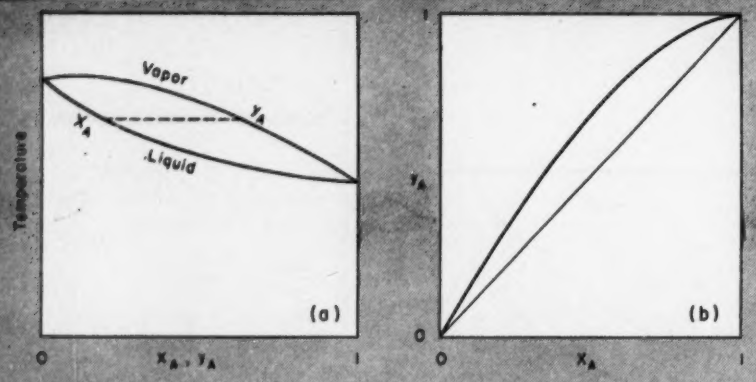


Fig. 2 - Normal miscible system

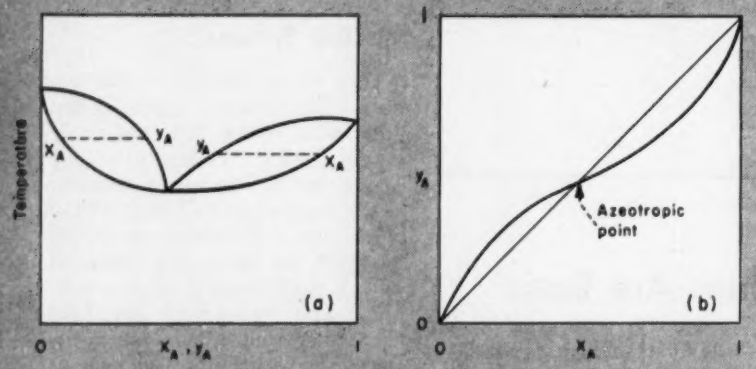


Fig. 3-Minimum boiling point azeotrope

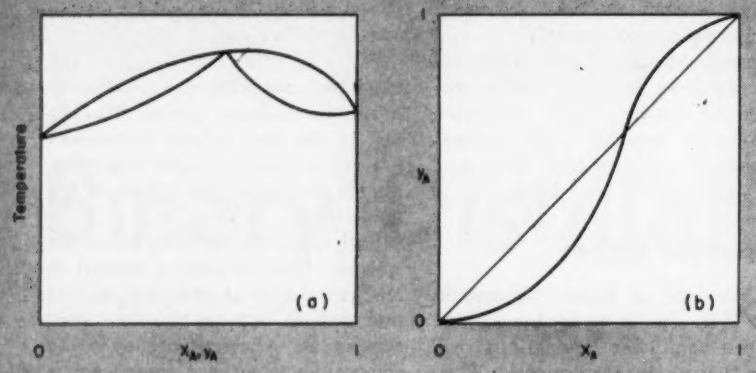


Fig. 4-Maximum boiling point azeotrope

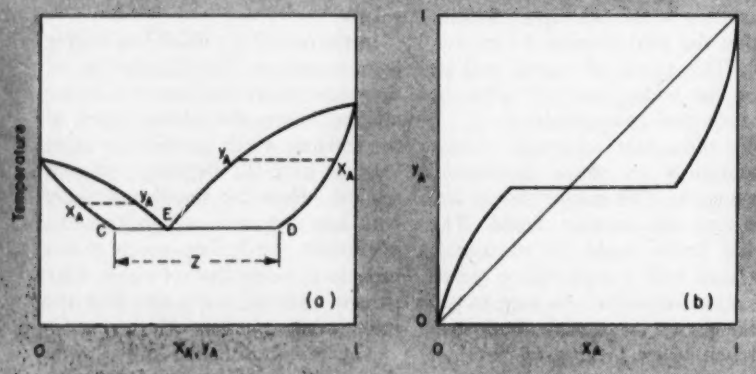


Fig. 5-Partially miscible system

the azeotrope is above the boiling point of either of the two pure components.

Figs. 3(b) and 4(b), the composition diagrams of these phenomena, can be misleading. Actually, Fig. 4(b) would look just like Fig. 3(b) if we plotted x_B vs. y_B instead of x_A vs. y_A. In order to avoid confusion we must consistently plot the compositions in terms of the component with the lower boiling point (normally the most volatile).

Partially Miscible Systems

The partially miscible system (Fig. 5) is a special case of the minimum boiling point azeotrope. Fig. 5(a) is merely Fig. 3(a) with the bottom flattened.

Basic distinction of this type of system is that over a range of liquid composition (instead of a single point) the vapor composition and the boiling point are constant. This is not surprising; over the liquid composition range Z there are two immiscible liquid phases of compositions C and D, each having an equilibrium vapor composition E. The only physical change that occurs as the over-all liquid composition changes within the zone Z is the variation of the relative amounts of the two immiscible liquid phases.

Ideal Systems

The "ideal" binary liquid-vapor system is a special case of the normal-miscible.

In the ideal system we assume that the components have no effect on each other. Each component acts independently and presents a tendency for volatilization only as a function of its concentration in the liquid phase and its vapor pressure at the temperature of the system. Raoult's law expresses this condition mathematically as follows:

$$p_A = P_A x_A \qquad (4)$$

If we divide both sides of the equation by the total pressure of the system π,

$$p_A/\pi = P_A x_A/\pi \qquad (5)$$

and apply Dalton's law of partial pressures, we get

$$y_A = P_A x_A/\pi \qquad (6)$$

How to Calculate the Equilibrium Curve for an Ideal System

Problem—Assuming constant relative volatility and Raoult's law, calculate the vapor-liquid equilibrium curve for the binary system, benzene-toluene.

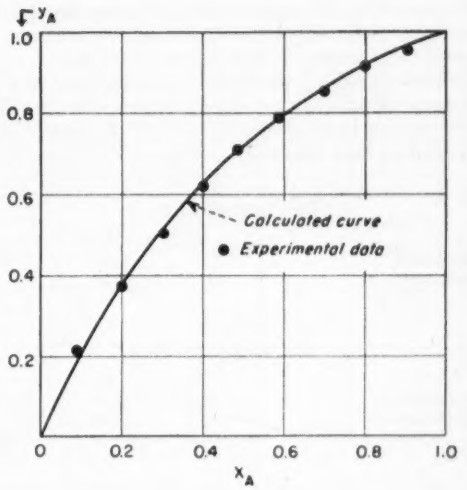
Solution—First determine the average relative volatility from vapor pressure data, then use Eq. (9) to calculate y_A for various assumed values of x_A.

Temperature	Vapor Pressure, P_A Benzene	Vapor Pressure, P_B Toluene	$\alpha_{AB} = P_A/P_B$
80.1 C.	760 mm.	270 mm.	2.81
110.6 C.	1,780 mm.	760 mm.	2.34

$$\alpha_{AB}\ (\text{avg.}) = (2.81 \times 2.34)^{0.5} = 2.52$$

$$y_A = \frac{2.52x_A}{1 + 1.52x_A}$$

x_A	$2.52x_A$	$1.52x_A$	$1 + 1.52x_A$	y_A
0.1	0.252	0.152	1.152	0.201
0.2	0.504	0.304	1.304	0.386
0.3	0.756	0.456	1.456	0.519
0.4	1.008	0.608	1.608	0.637
0.5	1.260	0.760	1.760	0.717
0.6	1.512	0.912	1.912	0.791
0.7	1.764	1.064	2.064	0.855
0.8	2.016	1.216	2.216	0.911
0.9	2.268	1.368	2.368	0.957



and

$$y_B = P_B x_B/\pi \qquad (6a)$$

Since

$$\alpha_{AB} = \frac{y_A/x_A}{y_B/x_B} \qquad (1)$$

then

$$\alpha_{AB} = \frac{P_A/\pi}{P_B/\pi} = P_A/P_B \qquad (7)$$

Thus the relative volatility of an ideal system at any composition is equal to the ratio of the vapor pressures of the two components at the boiling point of the mixture.

In many cases we can assume for calculation purposes a constant or average volatility for an ideal or near-ideal system. This assumption is quite valid for systems of homologous substances. To find an average relative volatility, we take the root mean square of the relative volatilities of the system at the boiling point of each component.

With the assumption of a constant or average relative volatility, we can develop a vapor-liquid equilibrium diagram analytically. By definition,

$$\alpha_{AB} = \frac{y_A/x_A}{y_B/x_B} \qquad (1)$$

Since

$$y_B = 1 - y_A$$

and

$$x_B = 1 - x_A$$

then

$$\alpha_{AB} = \frac{y_A/x_A}{(1 - y_A)\ (1 - x_A)} \qquad (8)$$

or

$$y_A = \frac{\alpha_{AB}x_A}{1 + (\alpha_{AB} - 1)\ x_A} \qquad (9)$$

By assuming various values for x_A in Eq. (9) we compute corresponding values for y_A and plot an equilibrium diagram. Above is an example of the calculation of the vapor-liquid equilibrium diagram for the benzene-toluene system and the results compared with experimental data. Average error by assumption of a constant relative volatility was 1.2%.

Nonideal Systems

Let's turn next to the more challenging group, the nonideal systems. Here the molecules don't behave in a mixture as they would independently. Their tendency to escape from the liquid phase to the vapor phase is not always reflective of their measured vapor pressure.

To understand the phenomena involved requires the use of thermodynamics. The second law tells us that in an equilibrium phase change at constant temperature and pressure, the free energy of a component must be the same in both phases. Stated mathematically,

$$F_A\ (\text{liquid}) = F_A\ (\text{vapor}) \qquad (10)$$

Free energy is related to fugacity f by

$$F = RT \ln f + B \qquad (11)$$

where R is the gas law constant and T is absolute temperature. Thus,

$$RT \ln f_A\ (\text{liquid}) + B = RT \ln f_A\ (\text{vapor}) + B \qquad (12)$$

or

$$f_A\ (\text{liquid}) = f_A\ (\text{vapor}) \qquad (13)$$

This f, the fugacity, is essentially the escaping tendency of component A from one phase to another. At equilibrium the escaping tendency from each phase into the other must be the same and, therefore, the fugacity of each component in both phases must be the same. Thus, the analysis of phase relationships requires only the application of fugacity data.

Deviations from ideality result from two factors: (1) Pressure-temperature effect on behavior and (2) interaction of one substance upon the other (attraction and repulsion of molecules).

How to Calculate Equilibrium Composition At Elevated Pressure

Problem—Find the vapor composition in equilibrium with a liquid whose composition is 30 mole % n-butane, 70 mole % n-hexane. System pressure is 70 psia.

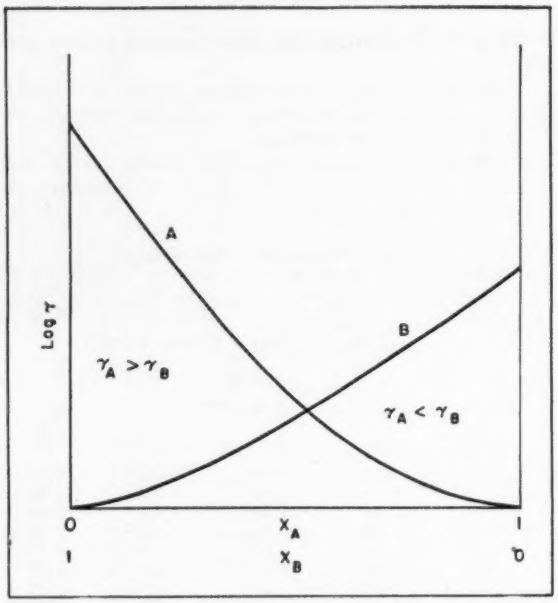
Solution—Assume a reasonable temperature and pick off corresponding values for the equilibrium constants from the Scheibel-Jenny nomograph or Perry's K charts. Calcu- y_A and y_B; they should add to 1.0.

Trial 1—Assume 160 F.

	x	K	$y = Kx$
n-butane	0.3	1.55	0.465
n-hexane	0.7	0.26	0.182
			$\Sigma y = 0.647$

Trial 2—Assume 200 F.

	x	K	$y = Kx$
n-butane	0.3	2.26	0.678
n-hexane	0.7	0.46	0.322
			$\Sigma y = 1.000$



In systems of homologous nature we can neglect the second factor, since intermixing of homologs does not normally cause intermolecular deviations from ideality. Thus in the case of homologous mixtures (applied most commonly to petroleum stocks) we can apply the Lewis rule for the fugacity of a component in a mixture. For the vapor phase,

$$f_A \text{ (vapor)} = y_A f_A^* \text{ (vapor)} \quad (14)$$

where f_A^* (vapor) is the fugacity of pure A at the temperature and pressure of the system. For the liquid phase,

$$f_A \text{ (liquid)} = x_A f_A^* \text{ (liquid)} \quad (15)$$

where f_A^* (liquid) is the fugacity of A at the temperature of the system and at the vapor pressure of A at that temperature.

Combining Eqs. (13), (14) and (15):

$$x_A f_A^* \text{ (liquid)} = y_A f_A^* \text{ (vapor)} \quad (16)$$

$$\frac{y_A}{x_A} = \frac{f_A^* \text{ (liquid)}}{f_A^* \text{ (vapor)}} = K \quad (17)$$

We have thus developed the x-y phase relationships for systems of homologous nature. These can be applied to multicomponent systems as well as binary systems. The relative volatility of any two components can also be represented by the K factors:

$$\alpha_{AB} = \frac{y_A/x_A}{y_B/x_B} = \frac{K_A}{K_B} \quad (18)$$

Thus application of thermodynamics can solve a simple nonideal system. The f^*'s can be determined from f/π vs. (P_R, T_R) charts or, for hydrocarbons, we can use the K-factor hydrocarbon nomograph developed by Scheibel and Jenny[10] or Perry's K charts.[11]

Nonhomologous Systems

We now come to the toughest case of liquid-vapor phase equilibria, the nonideal, nonhomologous system. Let's simplify our treatment by restricting it to systems operating at low or moderate pressures. (Actually this is not a severe restriction, inasmuch as many industrial problems observe this limitation in operation because of process and economic conditions.) By means of this limitation we simplify the complex analysis to the point where the nonideality of the components of only the liquid phase is considered, inasmuch as at low pressures the vapor phase behaves in an ideal manner.

Drawing again from thermodynamics, we utilize the activity concept, which is:

$$a_A = \gamma_A x_A \quad (19)$$

where a is the activity and γ is the activity coefficient.

Here is where it fits in. Back in the treatment of the ideal state we noted the use of Raoult's law:

$$p_A = P_A x_A \quad (4)$$

However, for nonideal solutions x_A is not the true effective concentration affecting the tendency of component A to "escape" from the liquid phase. Actually the activity a is the true measure of this concentration. Therefore

$$p_A = P_A a_A \quad (20)$$

$$p_A = P_A \gamma_A x_A \quad (21)$$

$$p_A/\pi = \gamma_A x_A P_A/\pi = y_A \quad (22)$$

or

$$y_A/x_A = \gamma_A P_A/\pi \quad (23)$$

Relative volatility can be expressed in terms of the activity coefficient in the following manner:

$$\alpha_{AB} = \gamma_A P_A/\gamma_B P_B \quad (24)$$

This equation differs from the ideal system relationship only by the introduction of the activity coefficient term. It helps explain the behavior of azeotropic systems.

If the system is ideal the γ's will have a value of 1. However, molecular attractions and repulsions of unlike compounds result in deviations from ideality. If the molecular interactions cause the escaping tendency of a component to be greater than the ideal $p = Px$, γ will be greater than 1. If the molecular interaction reduces the escaping tendency to less than Px, then γ will be less than 1.

Normally, as we shall see, we deal with the logarithm of the measure of

How to Calculate Equilibrium Data For an Azeotropic System

Problem—Calculate the vapor-liquid equilibrium curve at atmospheric pressurt for the system water-normal propanol. The system exhibits an azeotropic point at a mole fraction of propanol $x_A = y_A = 0.432$ and a temperature of 87.8 C.
Solution—Calculate the activity coefficients for the two components at the point of azeotropism via Eq. (22). Calculate constants C_A and C_B via Eqs. (30) and (31). Using these constants, calculate activity coefficients for various assumed values of x_A. At each value of x_A, estimate the temperature and calculate y_A and y_B via Eq. (22), adjusting temperature to get their sum = 1.0.

From Eq. (22),

$$\gamma_A = \frac{y_A \pi}{x_A P_A}$$

$$\gamma_B = \frac{y_B \pi}{x_B P_B}$$

At 87.8 C., $P_A = 524$ mm. and $P_B = 483$ mm. Since this is the point of azeotropism, $x_A = y_A$ and $x_B = y_B$. Therefore,

$$\gamma_A = 760/524 = 1.41$$
$$\gamma_B = 760/483 = 1.57$$

Calculating the Van Laar constants at the point of azeotropism,

$$C_A = 2.3 \log 1.41 \left(1 + \frac{0.568 \log 1.57}{0.432 \log 1.41}\right)^2 = 2.60$$

$$C_B = 2.3 \log 1.57 \left(1 + \frac{0.432 \log 1.41}{0.568 \log 1.57}\right)^2 = 1.13$$

Calculate activity coefficient at $x_A = 0.1$, $x_B = 0.9$, via Eqs. (28) and (29):

$$\log \gamma_A = \frac{2.60}{2.3\left[1 + \frac{(0.1)(2.60)}{(0.9)(1.13)}\right]^2}$$

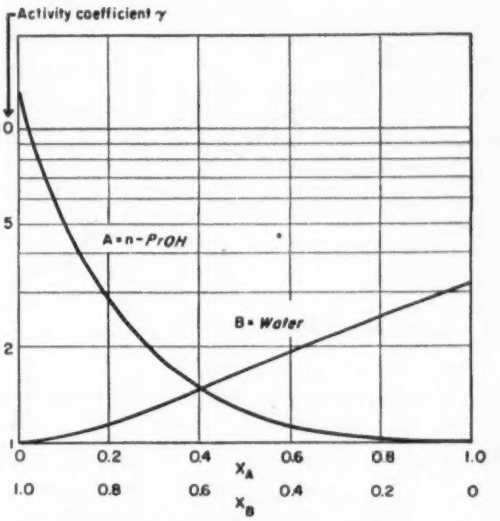
$$\gamma_A = 5.22$$

$$\log \gamma_B = \frac{1.13}{2.3\left[1 + \frac{(0.9)(1.13)}{(0.1)(2.60)}\right]^2}$$

$$\gamma_B = 1.049$$

Similarly, calculate γ_A and γ_B for various values of x_A. (These are shown on the graph above.) From γ_A and γ_B for $x_A = 0.1$, $x_B = 0.9$, calculate equilibrium vapor composition y_A and y_B.

Trial 1—Assume 88.5 C., at which temperature $P_A = 539$ mm. and $P_B = 496.7$ mm.



$$y_A = (5.22)\ (0.1)(539)/760 = 0.370$$
$$y_B = (1.049)(0.9)(496.7)/760 = 0.616$$
$$0.986$$

Trial 2—Assume 88.9 C., $P_A = 548$, $P_B = 504$

$$y_A = (5.22)\ (0.1)(548)/760 = 0.376$$
$$y_B = (1.049)(0.9)(504)/760 = 0.625$$
$$1.001$$

Similarly, calculate equilibrium compositions for various values of x_A. These are shown in the table, along with experimental data for comparison.

Comparison of Calculated and Experimental Equilibrium Data

x_A	γ_A	γ_B	y_A, Calculated	y_A, Experimental	% Difference
0.1	5.22	1.049	0.376	0.372	1.07
0.2	2.86	1.161	0.401	0.392	2.29
0.3	1.93	1.32	0.405	0.404	0.25
0.4	1.486	1.51	0.414	0.424	2.36
0.432	1.41	1.58	0.432	0.432	0.00
0.5	1.268	1.73	0.442	0.452	2.21
0.6	1.14	1.97	0.483	0.492	1.83
0.7	1.064	2.24	0.547	0.551	0.73
0.8	1.025	2.52	0.592	0.641	0.76
0.9	1.007	2.80	0.780	0.778	0.26

deviation from ideality. Thus if γ is more than 1, its logarithm will be greater than zero, and we have a positive deviation. If γ is less than 1, the logarithm will be less than zero; we have a negative deviation.

These deviations from ideal behavior vary with the composition of the mixture. Thus the relative volatility of the components is not constant, as in an ideal system. In fact, in azeotropic systems the effect of the variations in the γ's of both components with composition is such that a reversal of relative volatility occurs. This phenomenon is noted in Fig. 6.

Note that in spite of component A exerting the higher vapor pressure, γ_B can exceed γ_A by such an amount as to overcome the difference in vapor pressure. Referring to Eq. (24), when γ_B/γ_A is greater than P_A/P_B, then α_{AB} is less than 1, even though A has the higher vapor pressure.

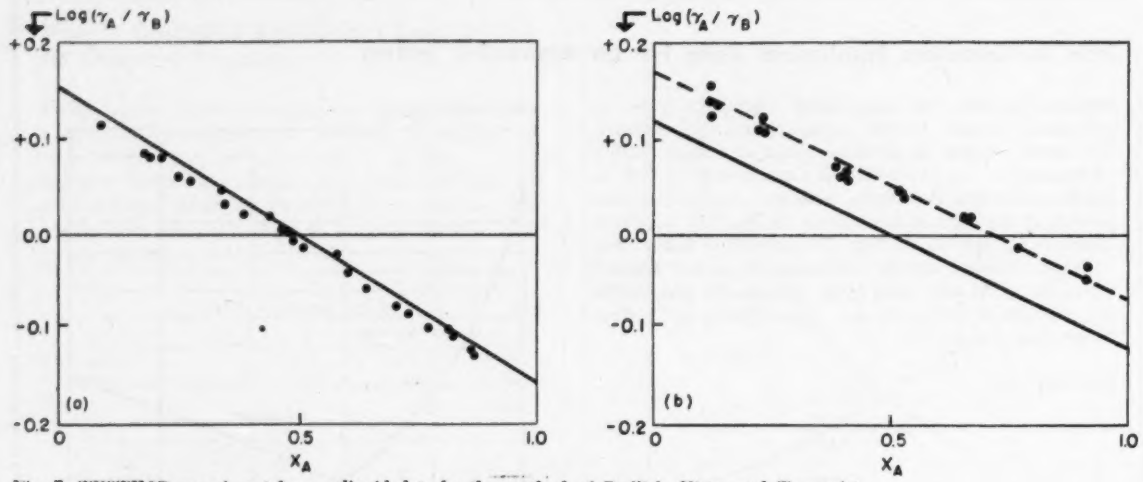


Fig. 7—TESTING experimental vapor-liquid data by the method of Redlick, Kister and Turnquist.

At the point of azeotropism,

$$\gamma_B/\gamma_A = P_A/P_B \qquad (25)$$

since $\alpha_{AB} = 1$. The relationship of the deviations from ideality of both substances is just sufficient to overcome the effect of difference in inherent volatility.

Predicting Nonideal Data

With this background of knowledge of the characteristics of nonideal mixtures we can now explain the methods of predicting the behavior of such systems.

All methods for analytical evaluation of binary system behavior relate back to the Gibbs-Duhem equation. For constant temperature and pressure,

$$x_A d\mathrm{G}_A + x_B d\mathrm{G}_B = 0 \qquad (26)$$

The G quantities are partial molal quantities, and we may substitute appropriate thermodynamic functions. Utilizing functions for free energy and its relationship with the deviation from ideality (still at constant temperature and pressure),

$$x_A\left(\frac{d \ln \gamma_A}{dx_A}\right)+x_B\left(\frac{d \ln \gamma_B}{dx_A}\right)= 0 \qquad (27)$$

With this equation we can predict the variations of γ_A and γ_B with composition. Of course, integration of this equation is necessary, and the most accurate integration is apparently still a matter of debate. The most useful solutions, however, are those by Van Laar,[9] and Redlick, Kister and Turnquist.[15] Their equations can be used only for approximations, inasmuch as actual systems vary in temperature over the range of composition studied. However, the results are quite good where the temperature change is less than 25 C. (If the temperature change were greater than that, separation by distillation would be so simple that we wouldn't need accurate equilibrium data!)

Use of these equations is twofold—prediction of vapor-liquid equilibria and smoothing out of experimental data.

For the prediction function let's use the Van Laar equation as an example:

$$\ln \gamma_A = \frac{C_A}{\left(1 + \frac{x_A C_A}{x_B C_B}\right)^2} \qquad (28)$$

$$\ln \gamma_B = \frac{C_B}{\left(1 + \frac{x_B C_B}{x_A C_A}\right)^2} \qquad (29)$$

where the constants C_A and C_B are

$$C_A = \ln \gamma_A\left(1 + \frac{x_B \ln \gamma_B}{x_A \ln \gamma_A}\right)^2 \qquad (30)$$

$$C_B = \ln \gamma_B\left(1 + \frac{x_A \ln \gamma_A}{x_B \ln \gamma_B}\right)^2 \qquad (31)$$

Thus, if we have one point of equilibrium data (for example, the point of azeotropism), we can calculate constants C_A and C_B. Once we have this information, we can calculate the γ-composition data from the Van Laar equation.

We know at this point that

$$y_A = \gamma_A P_A x_A/\pi \qquad (32)$$

and

$$y_B = \gamma_B P_B x_B/\pi$$

Thus we can calculate y_A and y_B for any x_A-x_B composition since we know γ_A, γ_B, x_A, x_B and π. The only data lacking are the vapor pressures P_A and P_B. These are functions of the temperature. Since we don't know the bubble points of these mixtures we must estimate them by a trial and error method. We estimate a bubble point, then find the vapor pressure of the components either from published data or from a Clausius-Clapeyron plot. We then compute y_A and y_B and see if they add up to 1. If not, we make successive trials.

Smoothing Nonideal Data

In engineering practice we're concerned not so much with the prediction of vapor-liquid equilibrium relationships as we are with the evaluation of the accuracy of experimental data. Smoothing out plots of log γ vs. x and having the two curves meet the Van Laar-Gibbs-Duhem requirements increases the utility of experimental data. The requirements are as follows.

(1) The slopes of the log γ vs. x curves should be of opposite sign at a given composition and in numerical ratio of x_A/x_B.

(2) At an x value of 0.5, log γ_A is approximately $\frac{1}{4}$ C_A and ln γ_B is approximately $\frac{1}{4}$ C_B.

Redlick and Kister's method is much more critical. Their integration

of the Gibbs-Duhem equation resulted in the following form:

$$\log (\gamma_A/\gamma_B) = dJ/dx_A \qquad (32)$$

where

$$J = x_A \log \gamma_A + x_B \log \gamma_B \qquad (33)$$

At $x_A = 0$, $\gamma_B = 1$, and at $x_B = 0$, $\gamma_A = 1$. Therefore, for either of the pure components, $J = 0$. Utilizing this fact we return to Eq. (32) and set it up in the integral form:

$$\int_{x_A = 0,\ x_B = 1}^{x_A = 1,\ x_B = 0} dJ = \int_0^1 \log (\gamma_A/\gamma_B)\, dx_A = 0 \qquad (34)$$

If, therefore, we plot $\log (\gamma_A/\gamma_B)$ vs. x_A, the area under the curve should be zero, as shown in Fig. 7(a).

Fig. 7(b) shows how to test experimental data. In this case the data form a smooth curve, but the summation of the area underneath the curve is not zero. Evidently there is a constant error in the experimental work. So we draw a curve, parallel to that formed by the data but displaced to meet the requirement of equal areas. This curve, then, correctly represents the vapor-liquid relationship.

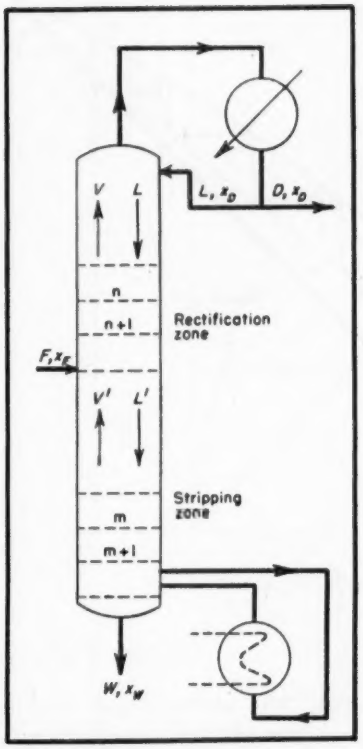


Fig. 9—MATERIAL balance diagram for continuous fractionation.

How to Apply Fractionation Theory

Here are methods for predicting the number of trays or transfer units for any condition, batch or continuous.

Now that we have reviewed the subject of phase equilibria, let's turn our attention to the profitable utilization of this material in design of distillation equipment.

We shall evaluate continuous distillation methods first, returning later to batch methods. This is because analysis of batch fractionation is based on continuous fractionation methods.

In addition we shall compare integral (stagewise) and differential mechanisms, both of which are applicable to batch and continuous fractionation.

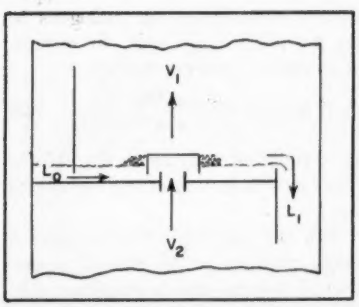


Fig. 8—UNIT of stagewise fractionation.

Fig. 8 illustrates the fundamental unit of stagewise fractionation, the plate or tray. Vapor V_2 rising into the plate meets with the cooler liquid L_0 coming down from above. Part of the vapor condenses, and the heat of condensation causes part of L_0 to vaporize. In the exchange process, vapor V_1 leaving the plate contains a greater proportion of the more volatile component than V_2, while liquid L_1 leaving the plate is leaner in the more volatile component than L_0, thus achieving fractionation.

The first analytical approach to fractionation was made in 1893 by Sorel. His method is still the only completely valid analysis of fractionation for both binary and multicomponent systems. It is based on a tray-to-tray calculation of material, enthalpy and equilibrium balances. However, its use is restricted—it takes too long, and sufficiently accurate enthalpy information if often not available.

McCabe-Thiele Method

The McCabe-Thiele method for analysis of binary fractionation has achieved widespread use, although, strictly speaking, it is limited to systems behaving in an almost ideal manner from the viewpoint of enthalpy considerations.

Basic assumptions of this method are: (1) Equal molal heats of vaporization of both components; (2) no heat of solution; (3) adiabatic operation.

Where these assumptions are valid we have equimolal overflow, i.e., one mole of incoming vapor V_2 condensing on the plate will release enough heat to vaporize a mole of material from liquid L_0. Thus the moles per hr. of vapor V rising from plate to plate and the moles per hr. of liquid L falling from plate to plate will both be constant. Under such conditions the analysis is greatly simplified.

Material balances on the column (Fig. 9) result in these equations:

Above the feed tray,

$$y_{n+1} = Lx_n/V + Dx_D/V \qquad (35)$$

and below the feed tray,

$$y_{m+1} = L'x_m/V' - Wx_W/V' \qquad (36)$$

where x and y refer to mole fractions of the more volatile component; D and W are moles per hr. of overhead and bottom products, respectively; subscripts *n* and *m* refer to trays above and below the feed, counting downward; and primes distinguish L and V below the feed from that above the feed.

Neither the vapor flow rate nor the liquid flow rate is necessarily the same in the two sections of the column, but they are constant within each section. The flow rates above and below

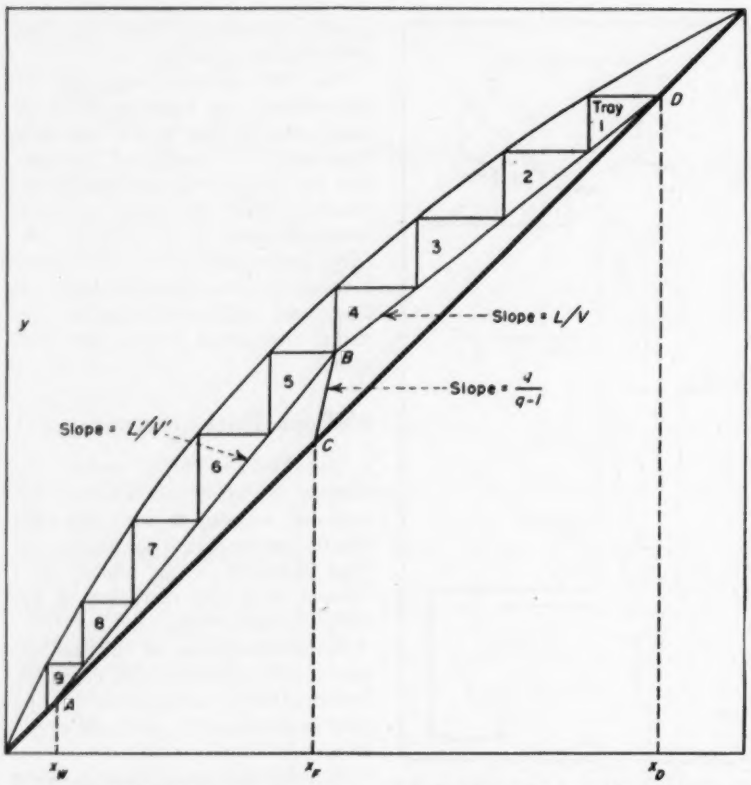


Fig. 10—GRAPHICAL analysis of continuous fractionation by McCabe-Thiele method.

the feed are related by the thermal condition of the feed:

$$V = V' + (1 - q)\,F \qquad (37)$$

and

$$L' = L + qF \qquad (38)$$

where q is the heat necessary to convert 1 mole of feed to saturated vapor divided by the molal heat of vaporization of feed, and F is moles per hr. of feed.

We find x_i, y_i, the intersection of lines representing Eqs. (35) and (36) —the operating lines—by simultaneous solution of Eqs. (35), (36), (37) and (38):

$$y_i = qx_i/(q - 1) - x_F\,(q - 1) \qquad (39)$$

We now have two material balance equations, (35) and (36), which relate the composition of the vapor rising from any tray with that of the liquid on the tray above. We also have the equilibrium curve, which relates the composition of the liquid on any (perfect) tray with the vapor rising from that same tray.

We can now perform a graphical analysis of a continuous fractionation column. Referring to Fig. 10, the procedure is as follows:

1. On the 45° line, locate points A, C and D, corresponding to liquid compositions x_W, x_F and x_D.
2. From point C, draw a line of slope $q/(q-1)$.
3. From point D, draw a line of slope L/V (rectification operating line), intersecting with the q-line at point B.
4. Draw line AB (stripping operating line).
5. Step off the theoretical plates.

We call L/V (the slope of the rectification operating line) the internal reflux ratio. This is different from the customary external reflux ratio R $(= L/D)$, but the two are related by:

$$\frac{L}{V} = \frac{L/D}{V/D} = \frac{L/D}{L/D + D/D} = \frac{R}{R+1} \qquad (40)$$

The extreme limits of column operation are minimum reflux and total reflux. At minimum reflux we need an infinite number of trays for the separation. This can happen in either of two ways:

(a) When the intersection of the operating lines (and q-line) occurs on the equilibrium curve (Fig. 11). We obviously can't get past B with a finite number of trays.

(b) When the operating line BD is tangential to the equilibrium curve (Fig. 12).

In the latter case, had we used the criterion of intersection of operating lines and q-line at the equilibrium curve (CD), the reflux ratio found would have been below the minimum. Thus it is essential to observe the physical characteristics of the equilibrium curve before applying any criteria for minimum reflux.

Minimum Number of Trays

The other condition of limitation, total reflux, is the case where all the overhead product is returned to the tower as reflux. Under this condition (Fig. 13), L/V and L'/V' are equal to 1 and the separation requires the minimum number of theoretical plates.

With total reflux, the vapor rising to any tray has the same composition as the liquid on that tray. As seen in Fig. 13, $x_2 = y_2$, $x_1 = y_2$, etc. This leads to an analytical relationship[7] between overhead and bottoms compositions and the minimum number of trays required for the separation:

$$(x_A/x_B)_D = \alpha_{AB}^{N_m}\,(x_A/x_B)_W \qquad (41)$$

where N_m is the minimum number of theoretical trays necessary for the separation. Stated in another way,

$$N_m = \frac{\log\,[(x_A/x_B)_D\,(x_B/x_A)_W]}{\log\,\alpha_{AB}} \qquad (42)$$

A variation of this equation (previously unpublished) is analogous to the x-y relationship used for systems of constant relative volatility:

$$(y_A)_F = \frac{\alpha_{AB}^{N_m}(x_A)_W}{1 + \alpha_{AB}^{N_m - 1}(x_A)_W} \qquad (43)$$

This equation reduces to Eq. 42 for direct determination of the number of trays.

We can use Eq. (42) to make a rough estimate of the ease of separation of systems with low relative volatilities. This procedure is based on a

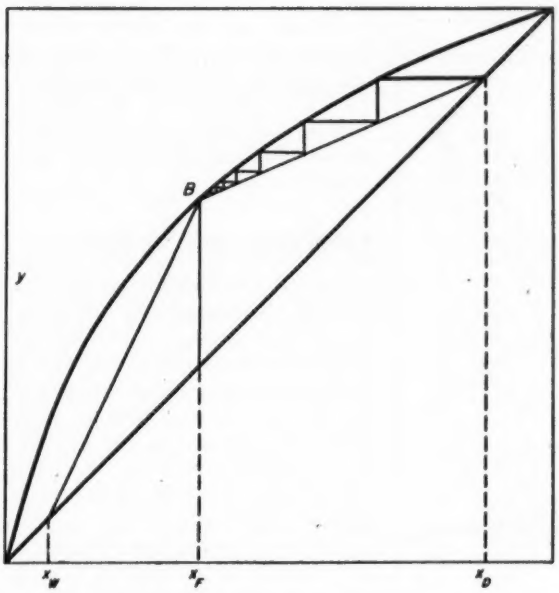


Fig. 11—MINIMUM reflux, usual case.

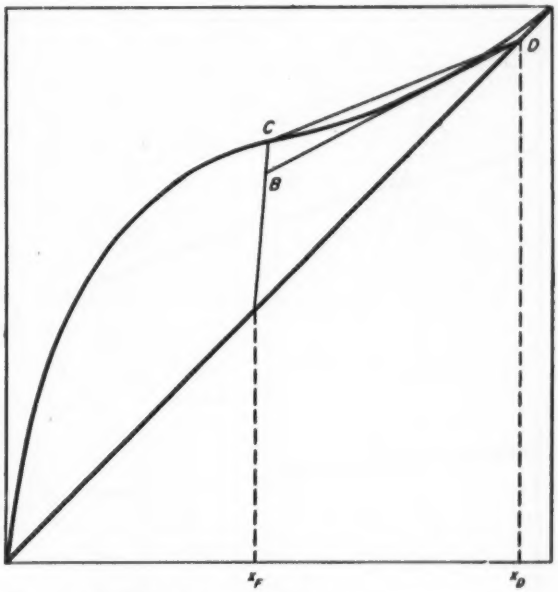


Fig. 12—MINIMUM reflux, special case.

distillate composition of 99% A and waste composition of 99% B. Thus

$$N_m = \frac{\log [(0.99/0.01)(0.99/0.01)]}{\log \alpha}$$

$$\sim \frac{\log 10^4}{\log \alpha} \qquad (44)$$

If α is close to 1.0, then $\log \alpha = \alpha - 1$. Therefore the minimum number of trays is $4\ (\alpha - 1)$.

Smoker's Method

So far we have reviewed the limiting conditions of fractionating column design and a graphical method of determining the number of theoretical plates required for a given separation at a finite reflux ratio. However, sometimes our system has a low relative volatility or our design conditions require a reflux ratio near the minimum. In such cases it is rather difficult to determine graphically the number of theoretical trays; the operating line is too close to the equilibrium curve.

Smoker[28] developed and analytical method that is adaptable to such situations. Based on a constant relative volatility, the relationship for rectification is as follows:

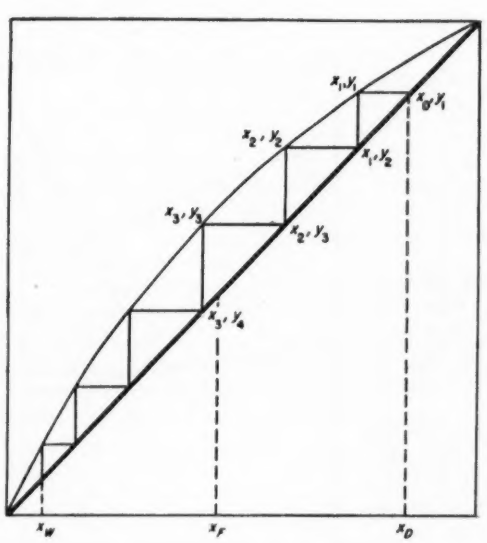


Fig. 13—TOTAL reflux gives minimum number of plates.

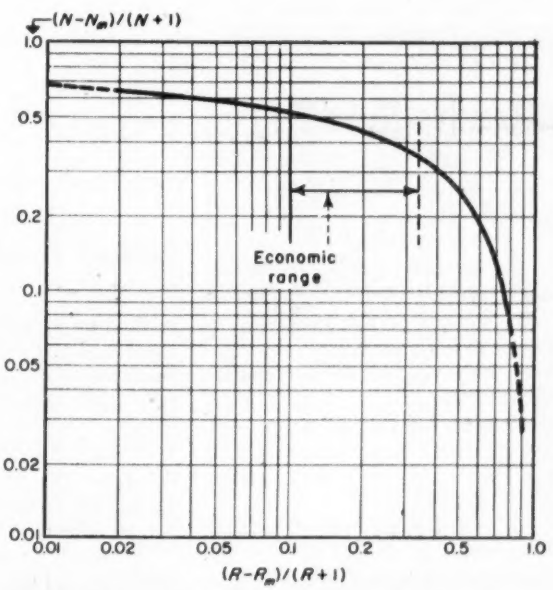


Fig. 14—GILLILAND correlation of plates and reflux ratio.

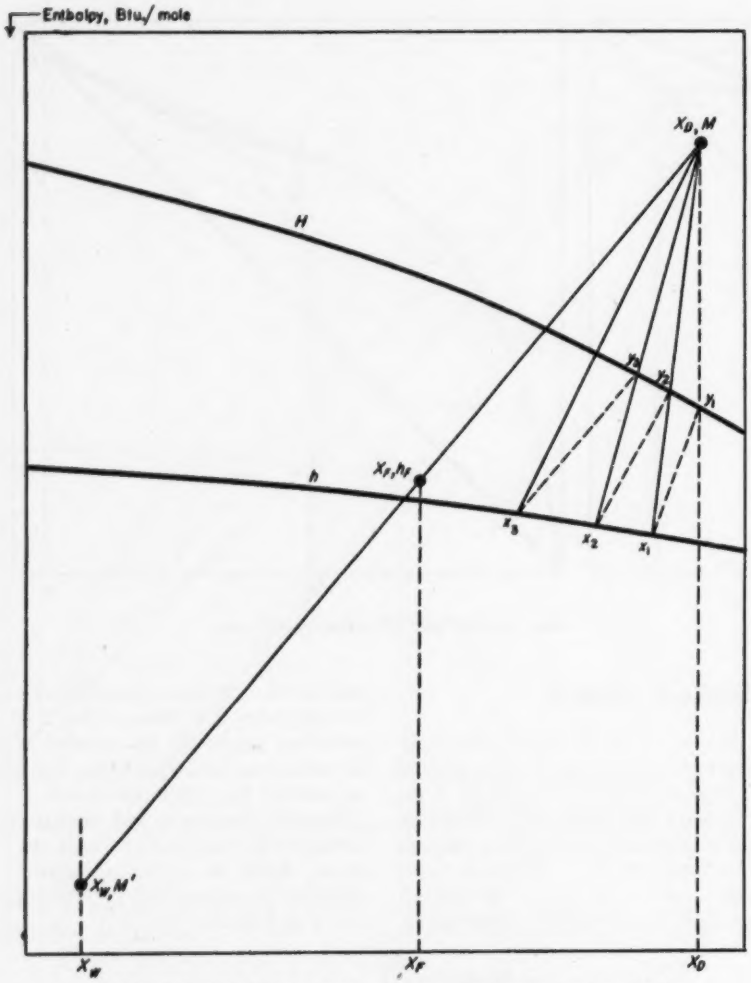


Fig. 15–PONCHON-SAVARIT method uses an enthalpy-composition diagram.

$$N = \frac{\log \dfrac{x_D'\left[1 - \dfrac{mc(\alpha - 1)x_F'}{\alpha - mc^2}\right]}{x_F'\left[1 - \dfrac{mc(\alpha - 1)x_D'}{\alpha - mc^2}\right]}}{\log (\alpha/mc^2)} \qquad (45)$$

First we find x_i, point of intersection of operating line and equilibrium curve. We can do this graphically, or we can solve simultaneously the equations for the equilibrium curve and the operating line.

We then compute $x_D' = x_D - x_i$ and $x_F' = x_F - x_i$. Quantity $c = 1 + (\alpha - 1)x_i$; m is the operating line slope L/V.

For stripping, we find x_i', point of intersection of stripping line and equilibrium curve, and get $x_W' = x_W - x_i'$ and $x_F'' = x_F - x_i'$. Use x_F'' for x_D' and x_W' for x_F' in Eq. (45), with $c = 1 + (\alpha - 1)x_i'$ and slope $m = \dfrac{Rx_F + x_D - (R + 1)x_W}{(R + 1)(x_F - x_W)}$

Gilliland Correlation

Gilliland[10] developed an empirical method for estimating the number of theoretical trays required for a given separation at any reflux ratio (Fig. 14). It is quite useful for initial approximations.

In order to use this method we first determine the minimum reflux ratio R_m and the minimum number of trays (at total reflux) N_m. Then for any reflux ratio R we compute $(R - R_m)/(R + 1)$, find the corresponding value of $(N - N_m)/(N + 1)$ from the graph, and finally get the value of N.

Gilliland observed that in all the columns he evaluated, economic operation was in the range of $(R - R_m)/(R + 1) = 0.1$ to 0.33. This may be used as a criterion in the initial estimation of reflux ratios for design purposes.

Ponchon-Savarit Method

This section, thus far, has used the McCabe-Thiele approach, with its inherent assumptions. Yet there are some binary systems that do not meet the requirement of equimolal heats of vaporization. In such cases we must have a more rigorous method of analysis, along with information concerning the enthalpy of the system as a function of composition.

Such a method is that of Ponchon and Savarit. In this method there is no assumption of equimolal overflow; it requires both material and enthalpy balances around the system. This gives, for above the feed plate (rectification):

$$\frac{x_D - x_{n-1}}{M - h_{n-1}} = \frac{x_D - y_n}{M - H_n} \qquad (46)$$

The operating line equation for the rectification zone is:

$$y_n = \left(\frac{M - H_n}{M - h_{n-1}}\right)x_{n-1} + \left(\frac{H_n - h_{n-1}}{M - h_{n-1}}\right)x_D \qquad (47)$$

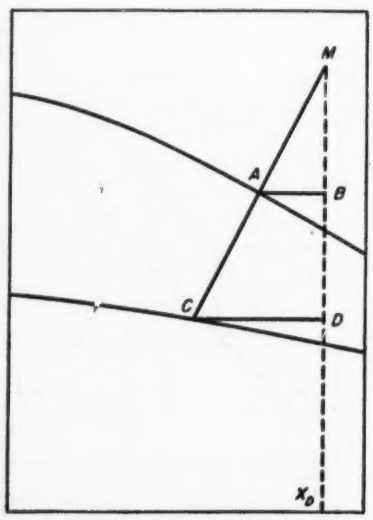


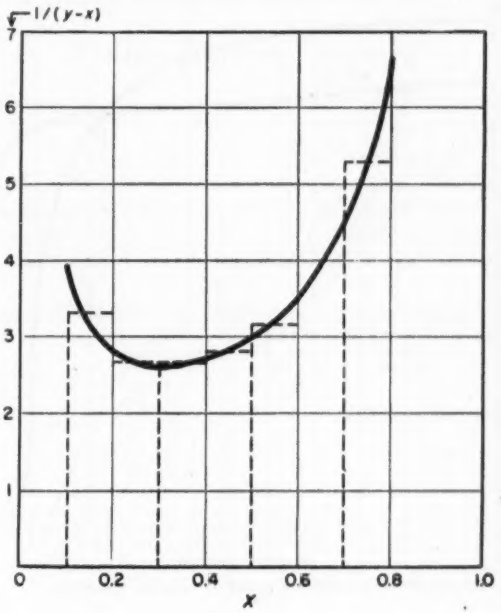
Fig. 16–PROOF of Ponchon method.

How to Calculate Simple Batch Distillation With the Rayleigh Equation

Problem—Given a two-component mixture whose initial composition x_o is 0.80 and relative volatility α is 5.0. Plot the instantaneous vapor composition vs. percent of material distilled overhead during a simple batch distillation.

Solution—From an x-y plot for $\alpha = 5.0$ (see Fig. 19) tabulate x and y values and from them calculate values for $1/(y - x)$. Plot x vs. $1/(y - x)$, as shown above, and graphically integrate in increments of $x = 0.1$. Equate each increment to $\ln (W_o/W)$. From the values of W_o/W thus found, calculate $[(W_o\text{-}W)/W_o]$ (100), the percent of material distilled overhead, and plot vs. y. See Fig. 17 for result.

x	y	y−x	1/(y−x)	Integral Area	W_o/W	$\frac{W_o-W}{W_o}(100)$
0.1	0.357	0.257	3.89	2.49	12.1	91.7
0.2	0.556	0.356	2.81	2.16	8.7	88.5
0.3	0.682	0.382	2.62	1.89	6.6	84.9
0.4	0.770	0.370	2.70	1.53	4.61	78.3
0.5	0.833	0.333	3.00	1.25	3.49	71.4
0.6	0.882	0.282	3.54	0.935	2.54	60.6
0.7	0.922	0.222	4.50	0.535	1.706	41.3
0.8	0.953	0.153	6.64	0	1	0



For below the feed plate (stripping) we have:

$$\frac{y_m - x_W}{H_m - M'} = \frac{x_{m-1} - x_W}{h_{m-1} - M'} \quad (48)$$

In these equations, H = molal enthalpy of vapor and h = molal enthalpy of liquid. M and M' are defined as follows:

$$M = (V_t H_t - L_t h_t)/D$$
$$M' = h_W - Q_W/W$$

where V_t = moles of vapor in overhead, L_t = moles of reflux and Q_W = heat input to reboiler.

In Fig. 15, the H curve represents the enthalpy of the vapor and h curve represents the enthalpy of the liquid, both as functions of composition. Point (x_D, M) is the operating focus for the rectification zone, point (x_W, M') is the operating focus for the stripping zone, and (x_F, h_F) represents the composition of the feed and its enthalpy. These three points lie on a straight line; therefore we need calculate only one of the quantities, M or M', in order to set up the diagram, since we know x_D, x_F, and x_W from the conditions of design.

Let's take a section of the diagram (Fig. 16) to see why and how it works. Note that similar triangles exist such that

$$\frac{CD}{MD} = \frac{AB}{MB} \quad (49)$$

If point A represents a condition of a tray (y_n, H_n) then C must represent the condition on the tray above (x_{n-1}, h_{n-1}) and

$$AB = x_D - y_n$$
$$CD = x_D - x_{n-1}$$
$$MB = M - H_n$$
$$MD = M - h_{n-1}$$

Substituting these values in Eq. (49):

$$\frac{x_D - x_{n-1}}{M - h_{n-1}} = \frac{x_D - y_n}{M - H_n}$$

thus fulfilling the requirements of the Ponchon-Savarit equation.

Seeing that a line originating at M connects the conditions of composition of two adjacent trays, and utilizing the equilibrium curve for correlating the conditions on each tray, we can proceed with a graphical analysis of the system. For example, in Fig. 15, $x_D = y_D$. From point y_D, the composition of the vapor rising from the top tray, we can find x_1, the liquid composition on the top tray, from the usual x-y equilibrium curve. Placing this point on the h curve (indicating the equilibrium by dotted line x_1y_D), we next connect x_1 to M. The intersection of Mx_1 with the H curve gives us y_2, and the analysis proceeds in a similar manner from this point on. We analyze the stripping zone in the same way, using M' as the focus.

Use of the Ponchon-Savarit method is desirable only where the molal heats of the mixture components are decidedly different and is possible only when enthalpy data for the system are available. Otherwise the McCabe-Thiele diagram is accurate enough.

Simple Batch Distillation

The earliest applications of differences in volatility for separation of liquids were via simple batch distillation (without rectification). This method is used industrially only for systems with high relative volatilities.

Rayleigh in 1902 analyzed simple batch distillation mathematically, getting this equation:

$$\ln (W_o/W) = \int_x^{x_o} \frac{dx}{y - x} \quad (50)$$

where W_o = moles of liquid of composition x_o in the pot at the start of operation and W = moles of liquid of composition x in the pot at any time.

For systems of constant relative volatility this becomes:

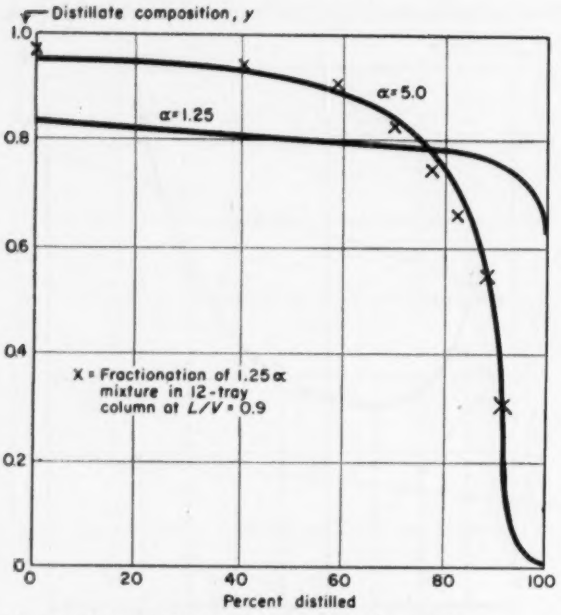


Fig. 17–BATCH distillation; effect of relative volatility.

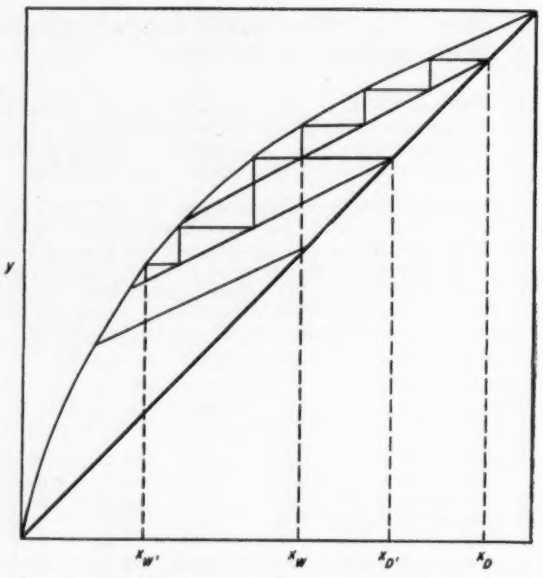


Fig. 18–BATCH fractionation analysis for three-tray column.

$$\ln (W/W_o) = \left(\frac{1}{\alpha-1}\right)\ln\left[\frac{x(1-x_o)}{x_o(1-x)}\right] + \ln\left(\frac{1-x_o}{1-x}\right) \quad (51)$$

Both equations relate the amount of material distilled with the instantaneous composition of the pot x at that moment.

These equations are useful in determining the cut-off point in batch distillation. Obviously, we must stop the distillation operation as soon as overhead composition falls below the minimum concentration specified for product purity.

To use Eq. (50) for determining the cut-off point, we proceed as follows:

1. Using the x-y phase equilibrium curve for data, make a plot of x vs. 1/(y-x). The area under the curve between values of x_o and x is equal to ln (W_o/W).

2. Calculate the quantity $[(W_o-W)/W_o](100)$ for each value of x and plot it against the y in equilibrium with x. This gives a plot of instantaneous vapor composition vs. percent of material distilled overhead.

Fig. 17 shows the results of such an analysis for systems having relative volatilities of 1.25 and 5.0, starting with a pot composition of 80 mole % more volatile component. Note that we can't get any effective enrichment of the more volatile component by simple batch distillation of the system having a relative volatility of 1.25. However, with the system of $\alpha \doteq 5$ we can get a product in excess of 90% purity having a mass of half that of the original charge and obtain the less volatile material in relatively high purity in the half left in the still.

Batch Fractionation

By adding a fractionation column to our batch still, however, we can achieve product purities with our 1.25α system comparable to those obtained with simple distillation of a 5α system. To make this kind of evaluation we must determine the instantaneous relationship of the overhead and the bottoms at a known reflux ratio in a column containing a given number of theoretical trays. Since concentrations vary with time in batch fractionation, we accumulate a sufficient amount of data concerning the instantaneous equilibrium conditions between bottoms and overhead and then plot a new equilibrium diagram for the system correlating instantaneous overhead and bottom compositions.

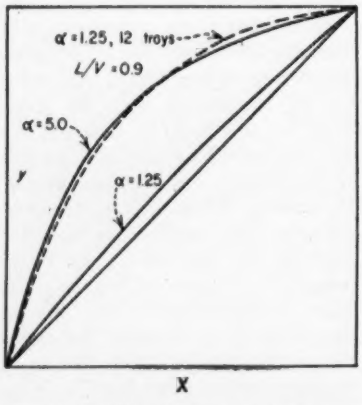


Fig. 19–HOW batch methods compare.

As noted in Fig. 18, we start with any overhead concentration x_D. We next draw the operating line, based on the predetermined reflux ratio, and step off the stated number of trays (in this case, three). At the end of three trays is x_W, the concentration of the bottoms in equilibrium with the overhead. We repeat this procedure (x_D', x_W', etc.) until we have sufficient data to plot a curve of x_D vs. x_W.

Fig. 19 shows the results of such a procedure with a system of relative volatility 1.25, a 12-tray column and an internal reflux ratio of 0.9. Note that batch fractionation of the 1.25α system in a 12-tray column gives approximately the same rectification as simple (one-stage) batch distillation of a 5α system.

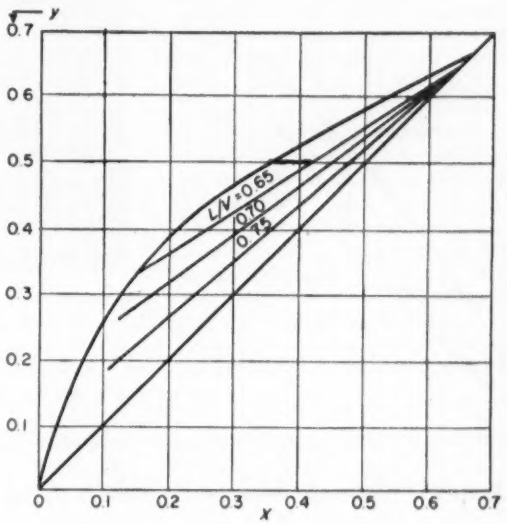
How to Calculate Continuous Batch Fractionation, Constant Distillate Composition

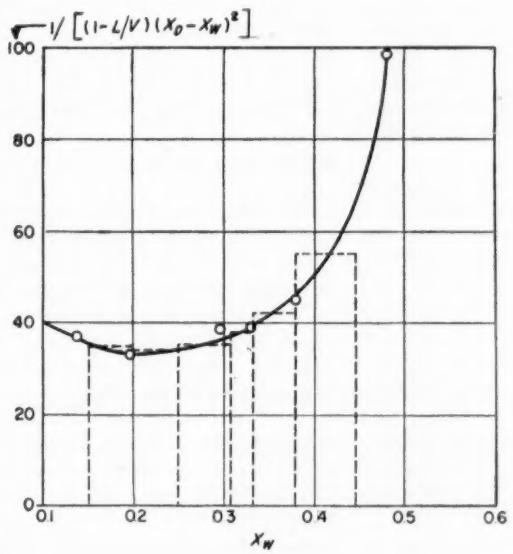
Problem—Given a still charge of 70 moles of a methyl acetate-methanol mixture with composition $x_s = 0.445$ mole fraction methyl acetate. The column has the equivalent of seven theoretical trays, and boilup rate is 225 gal. per hr., or in terms of distillate composition, V = 25.2 moles per hr. Determine the reflux rate-time relationship to get a constant distillate composition $x_D = 0.65$.

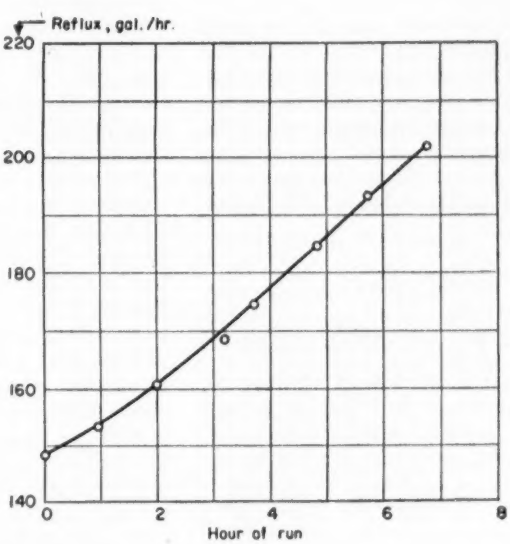
Solution—First check the molal heats of vaporization:

Methyl acetate = (98.09)(74) = 7,270 cal./gm.-mole
Methanol = (262.8)(32) = 8,100 cal./gm.-mole

These are close enough together to apply the McCabe-Thiele graphical method. Using the x-y diagram shown (which stops at the azeotropic point for this system), draw several L/V operating lines and step off seven trays to find the corresponding values of x_W. For each x_W value, calculate the quantity $1/[(1 - L/V)(x_D - x_W)^2]$ and plot vs. x_W. For increments of x_W, graphically determine the value of the integral of Eq. (52), then multiply by the constant term $W_s(x_D - x_s)/V$ (=0.561) to get θ. For each value of L/V, knowing V, calculate L, and plot this in terms of gal. per hr. vs. θ.







Data for Graphical Integration of Eq. (52)

L/V	1−L/V	x_W	$(x_D-x_W)^2$	$1/[(1-L/V)(x_D-x_W)^2]$
0.60	0.40	0.517	0.0151	165
0.65	0.35	0.480	0.0289	99
0.70	0.30	0.378	0.0741	45
0.75	0.25	0.330	0.1025	39.1
0.80	0.20	0.290	0.1295	38.8
0.85	0.15	0.196	0.206	32.3
0.90	0.10	0.135	0.265	37.3

Graphical Integration of Eq. (52)

x_W	L/V	Integral Area	θ	R	Reflux Rate, Gal./Hr.
0.445	0.66	0	0	1.94	148.5
0.417	0.682	1.68	0.942	2.14	153.5
0.380	0.715	3.57	2.0	2.51	160.9
0.330	0.750	5.70	3.2	3.0	168.5
0.305	0.775	6.65	3.73	3.44	174.3
0.248	0.820	8.63	4.84	4.55	184.5
0.200	0.857	10.28	5.76	6.0	192.6
0.150	0.895	12.01	6.75	8.5	201.5

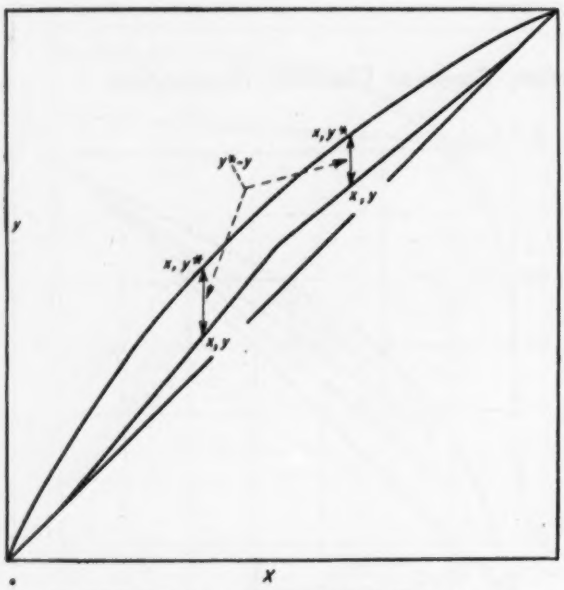


Fig. 20—DRIVING force in differential distillation is y* — y.

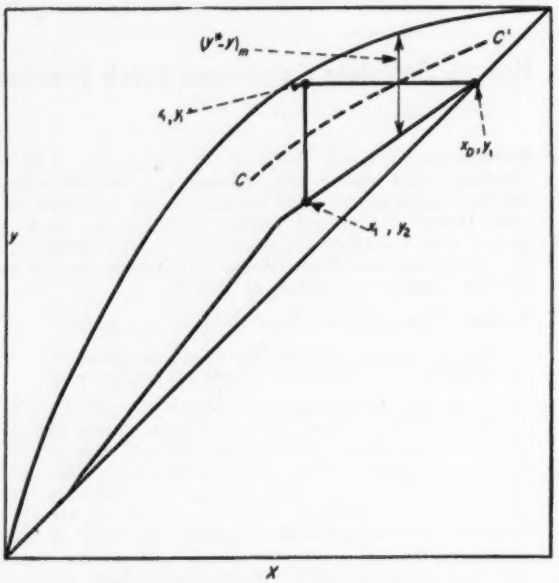


Fig. 21—GRAPHICAL method for estimating transfer units.

We have still another batch distillation technique that achieves results comparable with continuous fractionation. We can vary the reflux ratio with time, maintaining constant vapor rate, to get constant overhead composition

Bogart[1] developed an analytical treatment of the problem that is relatively simple to follow. His relationship is:

$$\theta = \frac{W_o(x_D - x_o)}{V} \int_{x_W}^{x_o} \frac{dx_W}{(1 - L/V)(x_D - x_W)^2} \quad (52)$$

where θ is the time at which the internal reflux ratio is L/V to get constant overhead composition x_D. By assuming various reflux ratios we find the pot composition for a constant overhead composition and a given number of theoretical trays. We then graphically integrate Eq. (52) by plotting:

$$\frac{1}{(1 - L/V)(x_D - x_W)^2} \text{ vs. } x_W$$

Differential Distillation

We have thus far concerned ourselves only with integral (stagewise) distillation, based on the assumption that vapor and liquid streams are in equilibrium on a theoretical tray. Plate columns represent the embodiment of integral distillation principles. Packed columns, however, operate in a different way, known as differential distillation. Here the changes in composition occur in differential amounts, and equilibrium is never achieved except in the limiting case.

Differential distillation is a true countercurrent process, similar to a single-pass countercurrent heat exchanger. The instantaneous driving force is in terms of concentration differences; it is the concentration of the more volatile component in a vapor that would be in equilibrium with the liquid phase minus the actual concentration of the more volatile component in the vapor phase. Diagrammatically the driving force is shown by the vertical distances in Fig. 20; algebraically it is the quantity $(y^* - y)$.

The same material balance used in integral distillation analysis applies to differential distillation, so that we use the same operating lines.

We can represent the actual compositions of the streams passing each other anywhere in the column by a point on the operating line. The y value represents the mole fraction of the more volatile component A in the vapor phase; the x value represents its mole fraction in the liquid phase. The y^* value represents the equilibrium composition of vapor for liquid composition x. Thus the driving force causing transfer of A into the vapor phase is $y^* - y$. We can see from Fig. 20 that this driving force varies continuously along the whole tower.

HETP and HTU

We should treat packed tower design, therefore, as a problem in kinetics, with the mass transfer rate as the major consideration. Yet the initial (and still used extensively) analysis of packed towers was based on stagewise design methods which assumed finite exchange steps.

Thus we have the HETP, which is the height of a packed section required to give the change in composition that would be provided by a theoretical plate. We can calculate the number of theoretical plates indicated by the performance of a packed column, divide the height of packing by this value and get an HETP. There are flaws in this procedure. The height of packing actually represents a time-area function which varies with rate of throughput. In addition the HETP will vary with composition.

Chilton and Colburn[3, 4] developed the concept of the transfer unit, based on differential mass transfer. Their derivation, based on a simultaneous solution of mass-transfer rate and ma-

terial balance, resulted in the relationships:

$$N_{OG} = \int_{y_1}^{y_2} dy/(y^* - y) \quad (53)$$

$$H_{OG} = Z/N_{OG} \quad (54)$$

where N_{OG} = number of transfer units necessary for the change in vapor composition from y_1 to y_2, H_{OG} = height of transfer unit and Z = packed height of column.

We can calculate the number of transfer units required for a given separation by plotting $1/(y^* - y)$ vs. y and graphically integrating the area under the curve.

From Eq. (53) we see that one transfer unit achieves a change in composition of the vapor phase equal to the mean driving force, or $\Delta y = (y^* - y)_m$. This suggests another approach (although less accurate) for the determination of the number of transfer units.

As seen in Fig. 21, we draw curve *CC'* halfway (vertically) between the equilibrium curve and the operating line. From x_D we draw a horizontal line intersecting curve *CC'* whose length $(x_D - x_1)$ is bisected at the point of intersection. The vertical dimension $(y^* - y)$ at the point of intersection is approximately (but not exactly) the mean driving force for the composition change x_D, y_1 to x_1, y_2. This change is thus approximately one transfer unit.

This graphical approach is convenient, inasmuch as it resembles the familiar McCabe-Thiele method. In the special case where the operating line and equilibrium curve are parallel, the transfer unit diagram will be identical with the tray diagram, and the number of theoretical plates will equal the number of transfer units. At total reflux the number of theoretical plates and number of transfer units are almost equal anyway, because the effects of convergence and divergence of the operating line and equilibrium curve are usually balanced at their extremities.

AARON J. TELLER is rapidly establishing a name for himself in the field of distillation.

And his name may become even more widely known via a new type of tower packing which he invented. Although Dr. Teller calls his packing the "rosette," Maurice A. Knight & Co., who has undertaken commercialization of this invention, has decided to name it the "Tellerette."

Dr. Teller's number one job is that of chairman of the chemical engineering and chemistry department at Fenn College, Cleveland, O. He spends his spare time in consulting work and professional activities. In fact, the rosette packing was developed in connection with a consulting job for Harshaw Chemical Co. He is active in the AIChE, having been chairman of the Cleveland section last year.

He holds degrees from Cooper Union, Brooklyn Poly and Case Institute.

Translating Theory Into Hardware

Here are the best methods for estimating height and diameter of full-scale distillation towers.

Equipment for integral distillation must provide a series of stages in which incoming liquid and vapor make intimate contact and then separate and travel to the next stage.

The bubble-cap tray is widely used for distillation work by the chemical and petroleum industries. In the last decade there has been a rash of new tray designs, most of which are variations of the bubble-cap or the older sieve plate, which had fallen into disuse.

In bubble-cap operation, the vapor travels upward through the riser, reverses its direction to pass through the cap slots, then bubbles through the liquid in a froth. The liquid can't flow down the vapor riser, even with zero vapor flow; thus the tray is stable even under variable operating conditions. Pressure drop per tray is rather high; it includes the liquid head on the tray as well as that contributed by flow restrictions and reversal.

The Uniflux tray,[8] which offers less pressure drop and allows easier fabrication, is essentially a bubble-cap tray. The Nutter float-valve tray[12] and the Koch Flexitray[21] are also modifications of the bubble-cap tray offering high stability with low liquid heads, thus achieving low pressure drop per tray.

The other basic type of tray, the sieve plate, boasts low construction cost and low pressure drop. However, an inherent weakness of this tray is its lack of stability under varying load conditions; that is, at low vapor velocities the liquid tends to drop through the perforations, leaving a dry, ineffective tray.

Among recent modifications of the sieve tray are the Benturi, the Turbogrid and the Kittel tray. The Koch Benturi permits low tray spacing and low pressure drop, while providing good mass transfer. The Shell Turbogrid[17] offers capacities exceeding that of bubble caps by 20 to 100%, with about one-half the pressure drop of the bubble-cap tray. The Kittel tray is also composed of perforated plates, made of triangular segments such that the liquid flow can be directed toward either the center or periphery of the tray by the angular motion of the vapor.

Tray Efficiency

In choosing the actual number of trays for a tower we must know how the performance of the tray compares with that of a theoretical or perfect tray. Unhappily most trays used com-

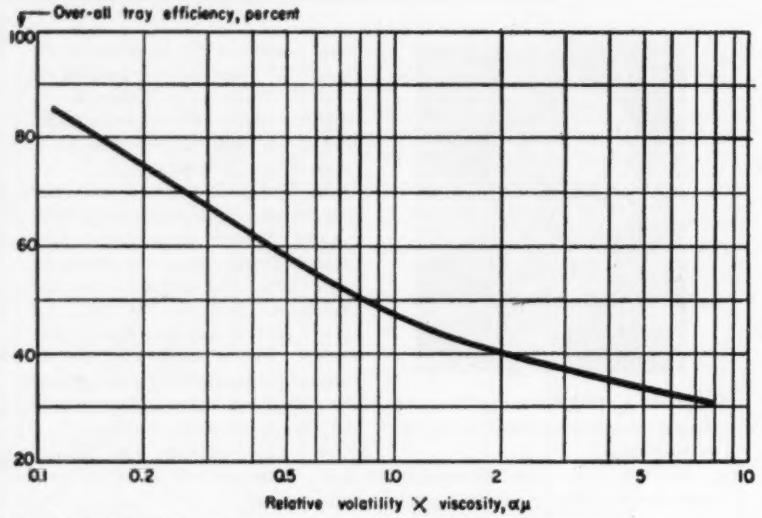


Fig. 22—OVER-ALL tray efficiency vs. relative volatility and viscosity.

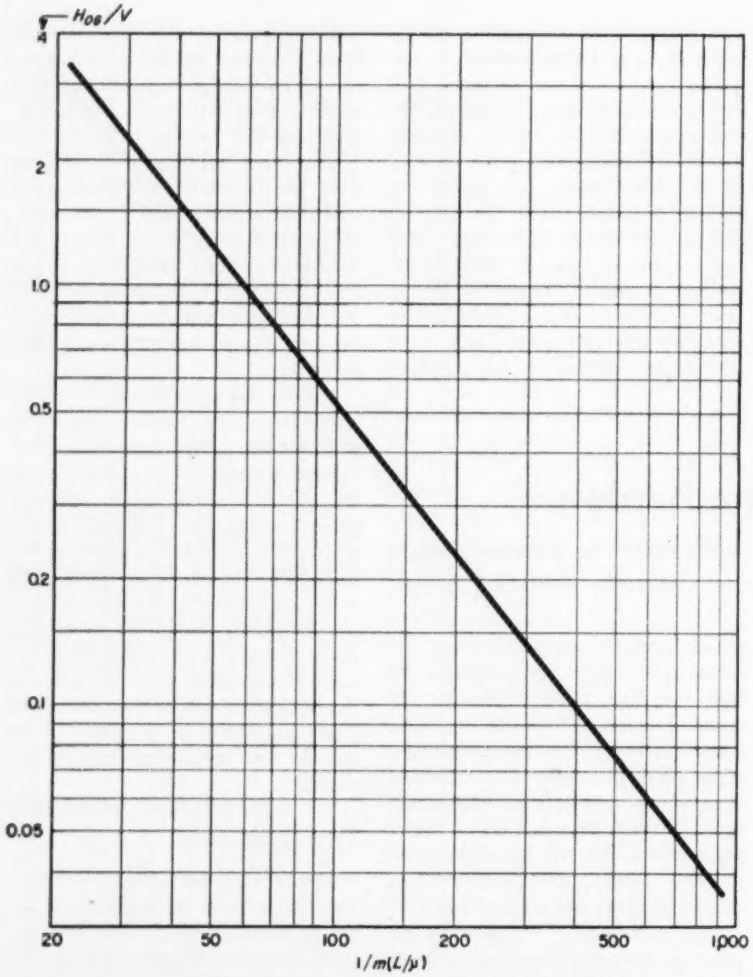


Fig. 23—GENERALIZED correlation of HTU data for rings and saddles.

mercially don't provide the equilibrium contact required of each unit by the theoretical calculations of the preceding section. Actually the number of real trays required for a given separation depends on the tray efficiency, which is a function not only of the tray design but also of the characteristics of the system being fractionated.

There are two methods of indicating the efficiency of a tray. One is the over-all efficiency:

$$E = \frac{N \text{ (theoretical)}}{N \text{ (actual)}} (100) \qquad (55)$$

The second is the Murphree efficiency:

$$E_{MV} = \frac{y_n(\text{av.}) - y_{n+1}(\text{av.})}{y_n^* - y_{n+1}(\text{av.})} (100) \qquad (56)$$

The Murphree efficiency relates the actual change in the vapor (or liquid) composition on the plate with that predicted theoretically (for example, by the McCabe-Thiele or Ponchon-Savarit relationships). It is valuable in actual tray design. Gerster et al[7] have developed generalized Murphree efficiency relationships for systems concerning which knowledge of transfer rates is available.

In general, however, chemical engineers prefer to use over-all tray efficiencies. Research in this area has not been too extensive and has in most cases been limited to bubble caps (although the new tray designs do not claim efficiencies much different from bubble-cap trays).

Drickamer and Bradford[8] found an empirical relationship of over-all tray efficiency with viscosity of the liquid. O'Connell[18] extended this relationship to include the relative volatility (Fig. 22), since with increasing α more mass has to be transferred per tray. Stated mathematically the O'Connell relationship is:

$$E = 49.2(\mu\alpha)^{-0.245} \qquad (57)$$

Williams[28] found that increasing the reflux ratio increased tray efficiency. However an attempt by Chu[5] to incorporate reflux ratio in O'Connell's relationship did not give any more accurate correlation with actual tower performance.

Thus, for general tower efficiency evaluation the O'Connell relationship is the best available.

In all the cases of tray efficiency evaluation we have discussed only sin-

Approximate Values of K_V in Eq. (58)*

Plate Spacing, In.	Liquid Seal, In. 0.5	1	2	3
12	0.09–0.11	0.07–0.09	0.05–0.07	
18	0.15	0.14	0.12	0.09
24	0.185	0.17	0.16	0.15
30	0.195	0.185	0.18	0.175

*Adapted from Perry's Handbook.

gle values of tray efficiency. This reflects a characteristic of bubble-cap columns—that efficiency is relatively constant over a wide range of boilup rates. This characteristic often favors the choice of tray columns over packed columns when other factors are equal.

Plate Column Diameter

The rate of vapor throughput of a tray tower is limited by two basic factors—entrainment of liquid in the vapor, leading to decrease in tray efficiency, and instability in operation, or flooding.

Many theoretical analyses have been made concerning the determination of limiting vapor velocities. However, because of the number and complexity of the contributing factors, empirical equations appear to be our best approach thus far. One that has achieved prominence in use is:

$$u_{max} = K_V \left(\frac{\rho_L - \rho_V}{\rho_V} \right)^{0.5} \qquad (58)$$

where u_{max} = superficial vapor velocity, ft./sec., ρ_L = liquid density and ρ_V = vapor density, both in lb./cu. ft., and K_V is a constant defined by materials and tray characteristics.

We determine minimum tower cross-section A_{min} from the maximum allowable vapor velocity. The zone in the tower where the maximum volume rate of vapor v_{max} occurs is usually at the top tray or in the feed zone. We compute the density of the vapor from the perfect gas laws (or from compressibility data if the column operates at high pressure). Then

$$A_{min} = \frac{v_{max}}{u_{max}} \qquad (59)$$

Although under some conditions liquid rate can affect tray stability (e.g., extremely high reflux rates), this factor is not encountered normally.

As a general rule of thumb, the minimum economic diameter for tray columns is in the range of 1½ to 2 ft. Below these diameters tray efficiency drops considerably because of a change in the type of liquid flow across the tray. In addition, fabrication costs are out of proportion for small-diameter columns.

Packed Tower Height

We can calculate the height of a packed tower required for a given fractionation by multiplying the number of transfer units times the height of a transfer unit, or by multiplying the number of theoretical plates required times the HETP. Data concerning HETP or HTU at total reflux for a large number of systems are given in the table on p. 187.

The efficiency of transfer (or HTU) of a packed column, unlike that of tray towers, varies with throughput. If only the effect of throughput is considered, then theoretically the column should lose slightly in efficiency as throughput is increased, since the quantities to be transferred go up as the first power of the throughput,

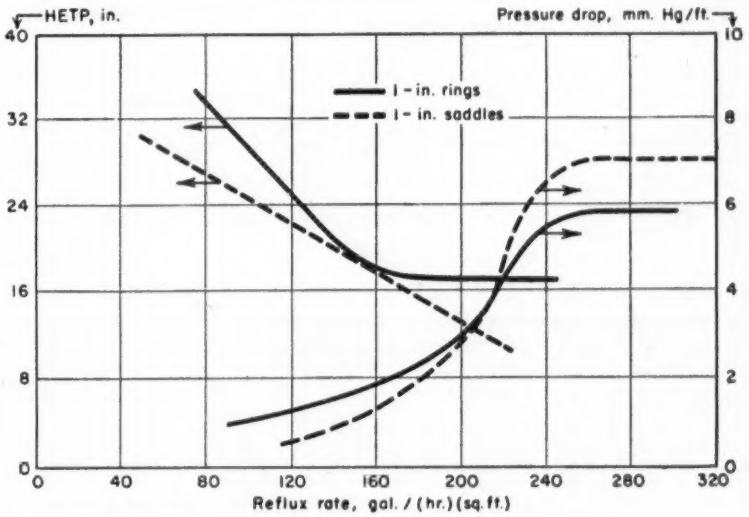


Fig. 24—COMPARISON of performance of 1-in. rings and saddles.

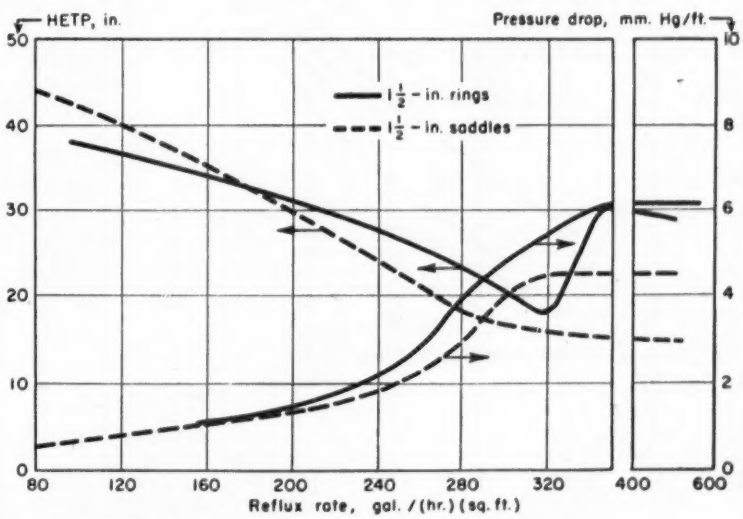


Fig. 25—COMPARISON of performance of 1½-in. rings and saddles.

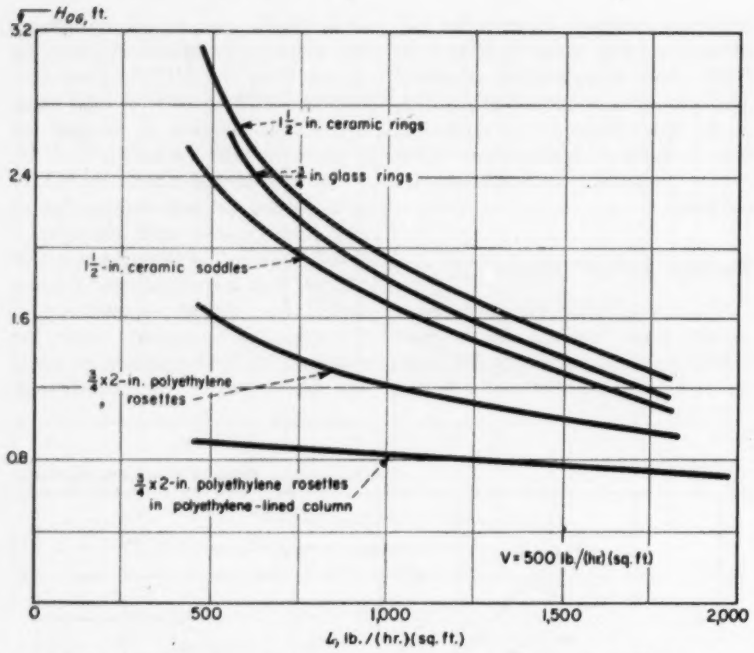
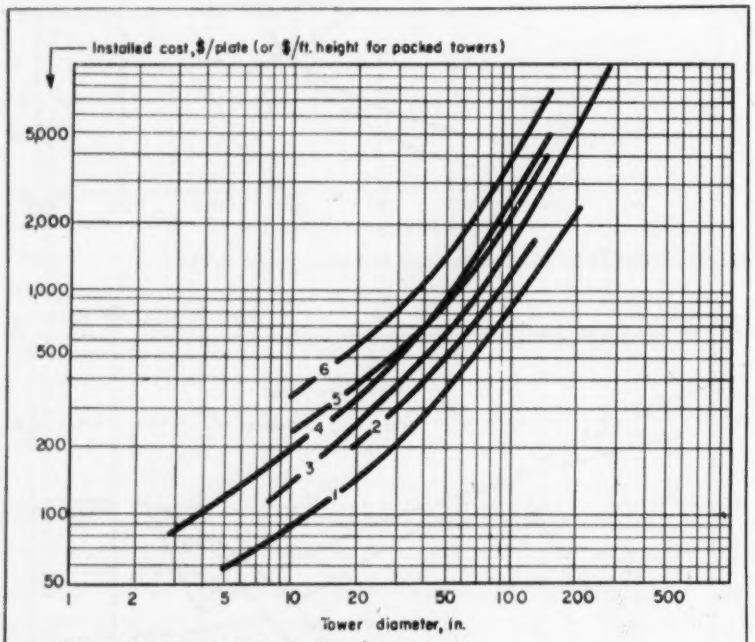


Fig. 26—ROSETTE packing performance compared with rings and saddles.



WHAT DO DISTILLATION TOWERS COST?

Curves represent approximate installed cost of distillation towers, obtained by correcting Chilton's data (**Chem. Eng.**, June 1949, p. 97) to June 1954 level (ENR index = 622, 1913 base). Tower cost = $/plate × number of plates or $/ft. × ft. packed height.

1—Packed, steel
2—Packed, Haveg
3—Packed, copper, or plate, steel
4—Packed, stainless steel
5—Plate, copper
6—Plate, stainless steel

whereas the mass-transfer coefficients go up presumably only as the 0.8 power of vapor and liquid velocities.

Despite such theoretical reasoning, performance of a packed column improves with throughput. Furnas and Taylor[8] indicated it might be due to improved wetting of the packing at higher liquid rates, whereas Teller[19] believed it was due to increased interstitial holdup at higher liquid rates.

Furnas and Taylor presented in graphical form an excellent evaluation of the performance of Raschig rings and Berl saddles (Fig. 23) in terms of transfer units. They indicated, in contradiction to generally accepted theories, that neither nominal size nor packing type affected efficiency of performance. Although the work was done on the ethanol-water system, we can use their HTU values for equivalent temperature and flow conditions with other systems by making the proper corrections to the gas-film and liquid-film HTU's.

In the general case, we make such corrections as follows:

$$\frac{H_G'}{H_G} = \frac{D_G}{D_G'} \qquad (60)$$

$$\frac{H_L'}{H_L} = \left(\frac{D_L}{D_L'}\right)^{0.5}\left(\frac{\rho_L}{\rho_L'}\right)^{0.5}\left(\frac{\mu_L'}{\mu_L}\right)^{0.5} \qquad (61)$$

where D_G = diffusivity in the vapor phase and D_L = diffusivity in the liquid phase.

To get the over-all HTU:

$$H_{OG} = H_G + (mV/L)H_L \qquad (62)$$

where m is the slope of the x-y equilibrium curve.

Actually, Furnas and Taylor claimed that liquid-phase transfer rate controlled the H_{OG}. Therefore, the only corrections we need make to convert their data to other systems are those of Eqs. (61) and (62).

Teller[20] compared HETP data for Raschig rings and Berl saddles in commercial sizes (Figs. 24 and 25). These data indicate that below flooding, equivalent sizes of these packings perform with similar results, but that the Berl saddle is more stable near the flooding zone and can be operated to 150% of flooding with stability and with slight increase in efficiency over that achieved just below flooding.

These two types have been the most popular tower packings of industrial size. In recent years several new indus-

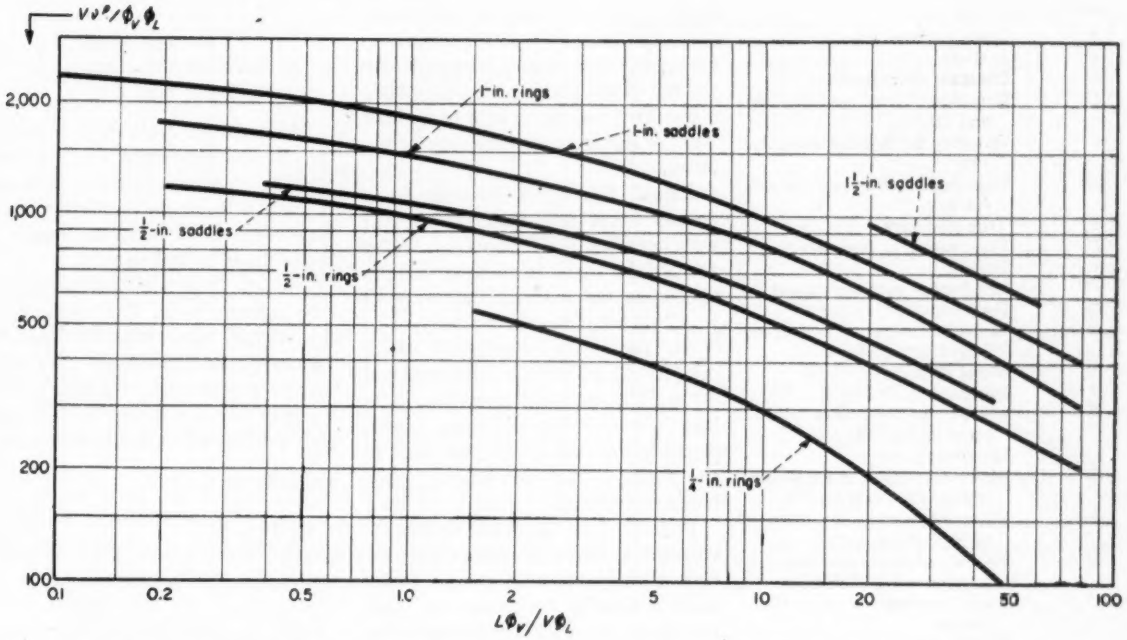


Fig. 27—FLOODING velocity correlation for various commercial tower packings includes corrections for density and viscosity.

trial packings have appeared on the market. Panapak packing, fabricated from metal lath, has a much higher capacity than rings or saddles. The Intalox saddle, apparently a modified Berl saddle, has also indicated high throughput with low pressure drop.

The Teller rosette (to be marketed under the name "Tellerette") was recently introduced for industrial use. Its design is based, not on wetted surface area, but on interstitial holdup; it can therefore be manufactured of nonwetting materials such as lightweight, corrosion-resistant polyethylene. Fig. 26 shows the performance of this packing as compared with other industrial packings.

There are other excellent packings, especially useful in laboratory columns, which provide efficiencies far greater than the common commercial packings. Among these are the Stedman, Fenske and McMahon packings.

Liquid, Vapor Distribution

To get top performance in packed columns we must have optimum distribution of liquid and vapor. Distribution is controlled by the method of loading the column with packing and by the type of distributor used.

Packing should be loaded so that only single units reach the packing zone at any instant. Otherwise there will be voids, and the packing efficiency will suffer. Where the packing is heavier than water, the units should be dropped individually through the column filled with water; if the packing is lighter than water (as in the case of some Tellerettes) the units should be dropped individually and tamped down at intervals. In all cases, after the column has been loaded it should be tapped or vibrated in some way. The settling action created by this procedure causes a contraction of packing volume as much as 10 to 15% and develops better distribution.

The liquid distributor is an important item. Unless the liquid is distributed evenly across the tower cross-section there will be zones where

Typical Performance Data for Experimental Packed Distillation Columns*

Packing	System	Column dia., in.	Packing depth, ft.	Liquid rate, lb./(hr.) (sq. ft.)	H_{oa} or HETP, ft.
½-in. ceramic or carbon rings	Isopropanol-water	6	4	150	0.3–0.6
	do.	6	4	450	0.3–0.6
	CCl_4-benzene	5	9	250	2.0
	do.	5	9	1,150	1.25
	Trichlorethylene-toluene	5	9	200	1.45
	do.	5	9	700	1.25
	do.	4.8	5	500	0.87
	do.	4.8	5	1,700	0.7
	do.	4.8	9	400	1.3
	do.	4.8	9	1,200	0.7
	Ethanol-water	5	9	550	1.0
½-in. ceramic saddles	do.	12	10	190	1.5
	do.	12	10	920	0.9
1-in. ceramic saddles	do.	12	9	150	1.4
	do.	12	9	960	1.1
1-in. ceramic rings	do.	12	10	785	1.2
2-in. ceramic rings	do.	12	10	816	2.2

* Adapted from Perry's Handbook

NOMENCLATURE

A	Cross-sectional area
a	Activity
B	Constant of integration
C	Constant defined by Eqs. (30) and (31)
c	Quantity defined following Eq. (45)
D	Overhead product rate, or diffusivity
E	Tray efficiency
F	Free energy, or feed rate
f	Fugacity
f^*	Fugacity of pure component
G	Partial molal quantity
H	Molal enthalpy of vapor, or height of transfer unit
h	Molal enthalpy of liquid
J	Quantity defined by Eq. (33)
K	y/x at equilibrium, or a constant in Eq. (58)
L	Liquid flow rate
M	Molecular weight, or a quantity defined following Eq. (48)
m	Slope of operating line, or slope of equilibrium curve
N	Number of theoretical trays, or number of transfer units
P	Vapor pressure of pure component
p	Partial pressure, or a packing constant
Q	Reboiler duty
q	Thermal condition of feed, defined in text
R	Gas law constant, or external reflux ratio
T	Absolute temperature
u	Superficial vapor velocity
V	Vapor flow rate
v	Vapor volume rate
W	Bottom product rate, or quantity in still
x	Mole fraction in liquid phase
y	Mole fraction in vapor phase
y^*	Mole fraction in vapor phase at equilibrium
Z	Packed height
α	Relative volatility
γ	Activity coefficient
θ	Time
μ	Viscosity
ν	Kinematic viscosity
π	Total pressure
ρ	Density
ϕ	Density correction factor defined in text

Subscripts

A, B	Component A, B
D	Overhead product
F	Feed
G	Gas
i	Point of intersection
L	Liquid
MV	Murphree, vapor
$m, m+1$	Plate in stripping section, counting downwards, or minimum, or mean
$n, n+1$	Plate in rectification section, counting downwards
o	Start of batch operation
OG	Over-all, based on gas film
t	Top of column
V	Vapor
W	Bottom product

little or no mass transfer will occur. The distributor, in addition to providing for even spread of liquid over the top of the packing, should provide a free area for vapor flow of at least 30% of the cross-sectional area of the tower.

Liquid flowing downwards in a packed tower will tend to hug the walls, causing maldistribution, below the first 10 to 15 ft. of tower height. Collectors and redistributors every 15 ft. will increase tower efficiency.

An alternative procedure,[19] which can produce an increase in efficiency of 30 to 50% in tower operation, is to insert a nonwetting wall liner. Liquid reaching the wall is reflected back to the packing, thus maintaining good liquid distribution.

Pressure drop in packed distillation columns is relatively unimportant except in high vacuum work. Under most distillation conditions the pressure drop does not affect the operating cost—at least not the way it does in absorption work, where gas pumping costs are significant.

Flooding Velocity

It is of greater importance that the column operate under stable conditions. The traditional limitation of stability has been the flooding point. However, Teller[20] recently showed that in some cases packed towers could operate under stable conditions above the flooding point.

Normally, packed distillation columns operate in the range of 70 to 90% of flooding, inasmuch as most columns show peak efficiencies just below flooding.

The most useful technique for the prediction of flooding rates for common industrial packings is based on Fig. 27, adapted from Perry's Handbook.[14] L and V are expressed in lb./(hr.) (sq. ft.). The factor ϕ_V corrects for vapor density as compared with the density of room-temperature air, or $\phi_V = (\rho_V/0.075)^{0.5}$; similarly, $\phi_L = (\rho_L/62.3)^{0.5}$ corrects for liquid density as compared with that of water. Correction for liquid viscosity is taken care of by the factor ν^p, where ν is the kinematic viscosity of the liquid μ/ρ, expressed in centistokes, and exponent p is a characteristic of the packing, as follows:

0.12	for ½-in. saddles
0.33	for ¾-in. rings
0.19	for ½-in. rings
0.15	for 1-in. rings

Although the correlation is empirical, it was developed from a large amount of published data. It is particularly valuable for distillation operations since it includes the effects of liquid viscosity and density.

Use of this relationship requires trial-and-error work. We usually know the internal reflux ratio L/V and the various physical constants. We must assume a value of L and find V from the graph, then compare the L/V ratio thus determined vs. the known value.

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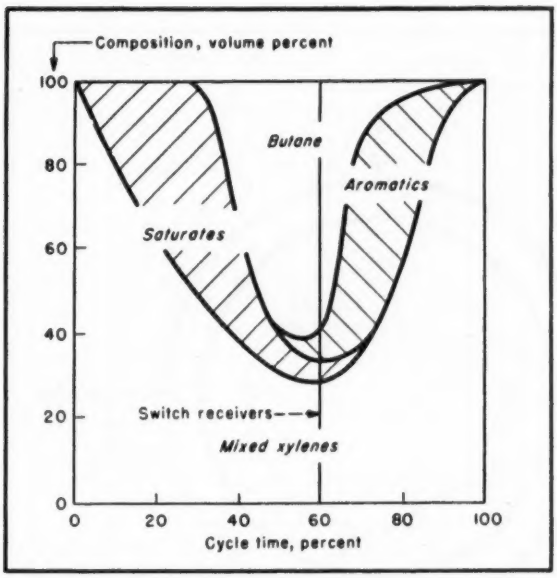

Fig. 1–SEPARATION by chromatography.

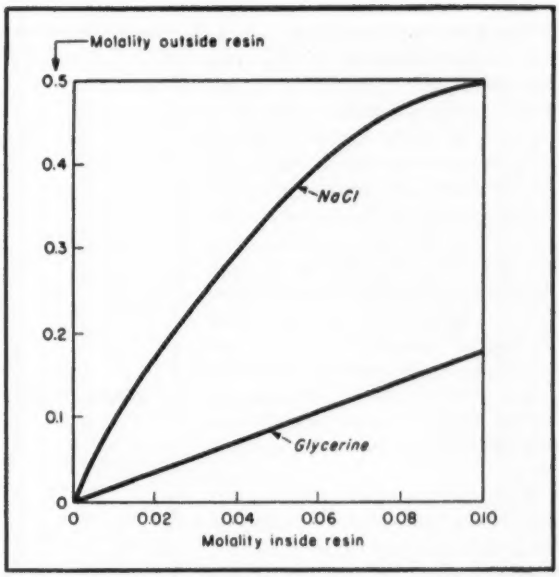

Fig. 2–SEPARATION by ion exclusion.

Let's Look at Selective Adsorption

Here's a fast review of the present status of this up and coming fractional separation technique, with some ideas on how continuous countercurrent operation—key to really broad usage—can be obtained.

GEORGE KARNOFSKY

Liquid phase separations based on adsorption are not as well understood as those more widely used like distillation and extraction. But the potential usefulness of fractional adsorption constantly becomes more apparent. Adsorbents now available include not only long-known materials like silica gel, activated carbon and alumina, but also a variety of synthetic resins whose properties can be varied for optimum performance. With increasing knowledge of these resins, the time may come when components of a liquid can be effectively separated by a made-to-order selective adsorbent.

Even now three techniques based on adsorption are available:

- Separation of non-ionics by selective adsorption on porous solids like carbon black and silica gel (chromatography).
- Separation of ions based on selective affinity for ion exchange resins.
- Separation of ionized substances from less ionized materials, in aqueous solution, based on selective exclusion from saturated ion exchange resins (ion exclusion process developed by Dow Chemical[1]).

For commercial use the processes described above will all benefit by continuous countercurrent operation. Well-known countercurrent liquid-solid contactors can be applied to adsorption processes and countercurrent systems can be designed by employing methods analogous to those used in other separation techniques.

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Scope of Our Discussion

For engineering purposes, adsorption may be defined as the unit operation concerned with mass transfer between fluid and solid surfaces. We think of adsorption first as a process by which minor constituents can be removed from a fluid, as in bleaching with earth or in odor removal. This is a saturation process like leaching, as distinguished from an exchange operation like rectification.

But we are concerned here with the less familiar exchange techniques by which adsorption is used to separate the constituents of a solution. A mixture can be separated into its components if they have different adsorbabilities. In a complete cyclic process they must be subsequently desorbed and the adsorbent returned to its original state to be reused. This is sometimes accomplished by heating the adsorbent, but here are described only those isothermal processes where the adsorbent is regenerated (made ready for adsorption) with a desorbing liquid.

Chromatographic Adsorption

If a dilute solution of the components to be separated is passed down through a column of adsorbent material the most strongly adsorbed component is captured at the top of the bed while less strongly adsorbed materials continue down the column to form individual zones. These zones are sharpened by pouring through the column a developer solvent which may be the same or different from the original. The individual adsorbed substances can be recovered, especially if they are colored, by carefully removing the adsorbent from the column and slicing it at the zone boundaries.

Adsorbed components can be separately recovered without cutting up the bed by passing through the column a strippant or elutant capable of desorbing them. The displaced components leave the bed in successive waves as eluate. Variations of this method are possible as exemplified by the following commercial operations:

• In the Sun Oil Co.'s Arosorb process, aromatics are separated from saturated hydrocarbons by selective adsorption on silica gel. First the feed mixture is poured through the bed where aromatics are more strongly adsorbed. The bed is first treated with butane, which displaces saturates which had been adsorbed to some extent, and then with mixed xylenes which desorb the aromatics. The adsorbent bed is now ready for more feed and the cycle is repeated. Fig. 1 shows the composition of the eluate during the cycle.[2]

• In the commercial separation of carotene, xanthophyll and chlorophyll[3], their dilute solution in hexane is first passed through a column of adsorbent carbon. Fresh hexane follows, develops the chromatogram and elutes carotene. Weak xanthophyll eluate from the previous run is pumped through the bed, followed by fresh xanthophyll elutant (a mixture of hexane and isopropanol). For chlorophyll elution, weak chlorophyll eluate from the last run passes down the bed first, followed by fresh chlorophyll elutant (a mixture of benzene and isopropanol). The column is flooded with benzene and the cycle repeated.

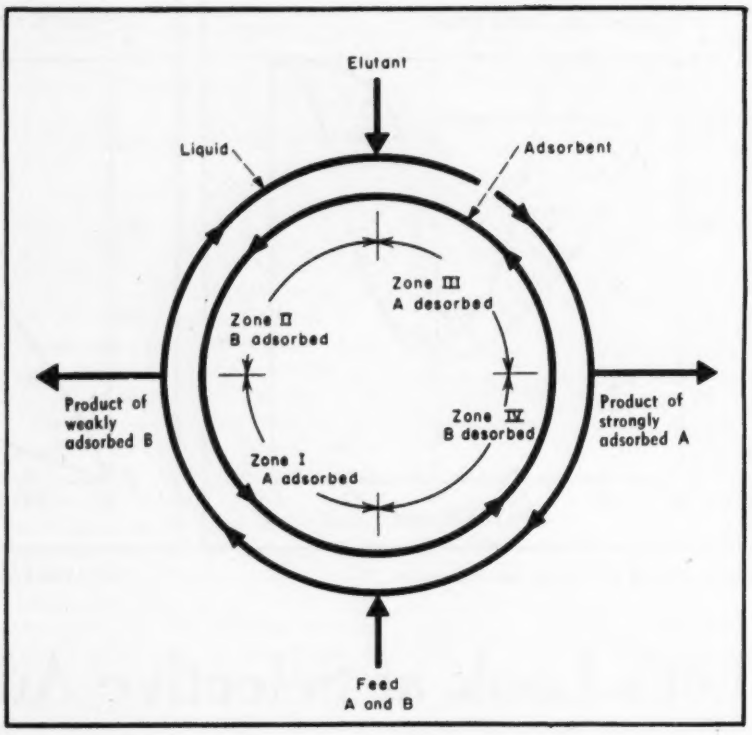


Fig. 3—PROCESS uses four-zone adsorption-elution cycle to separate components by continuous countercurrent selective adsorption.

Ion Exclusion

Glycerine in aqueous solution can be separated from sodium chloride by ion exclusion, using 50 to 100 mesh Dowex 50 (a sulfonated polystyrene type cation exchange resin), sodium form. Sodium chloride is much more strongly excluded from this resin than is glycerine.* They can be separated by a simple cycle in which a limited amount of feed solution is poured through a resin bed, followed by water for elution. The eluate will at first contain only salt and finally only glycerine and, if the bed is long enough, separation will be sharp.

Ion Separation

• Commercial separation of rare earth metals.

• Separation of lithium and potassium ions in dilute acid solution by selective adsorption on an ion exchange resin which is eluted by acid.

* The concentration of highly polar compounds like sodium chloride is often considerably greater (sometimes by a factor of ten) outside the resin particle than inside. Glycerine concentrations inside and outside are, on the other hand, nearly the same. See Fig. 2. The separation factor—equivalent to relative volatility in distillation—is, therefore, quite high.

Why Countercurrency

All the processes described have obvious faults characteristic of batch cyclic operation: excessive dilution of products by elutant; intermittent feed and product flow; constantly changing product concentration.

Intermittent flow and varying concentration can be largely overcome by providing a number of beds in parallel whose cycles are staggered, but excessive dilution can only be avoided by countercurrent operation. Reuse of weak eluate from the last batch, as practiced in the chlorophyll-carotene-xanthophyll separation, is a step in this direction. However, any scheme of recycling through a single bed which would give product concentration approaching what is possible by countercurrent separation would probably be commercially impractical.

How to Get Countercurrency

For complete separation of two components, A and B, in a continuous process using a single elutant, the operation shown diagramatically in Fig. 3 may be employed[4]. Here ad-

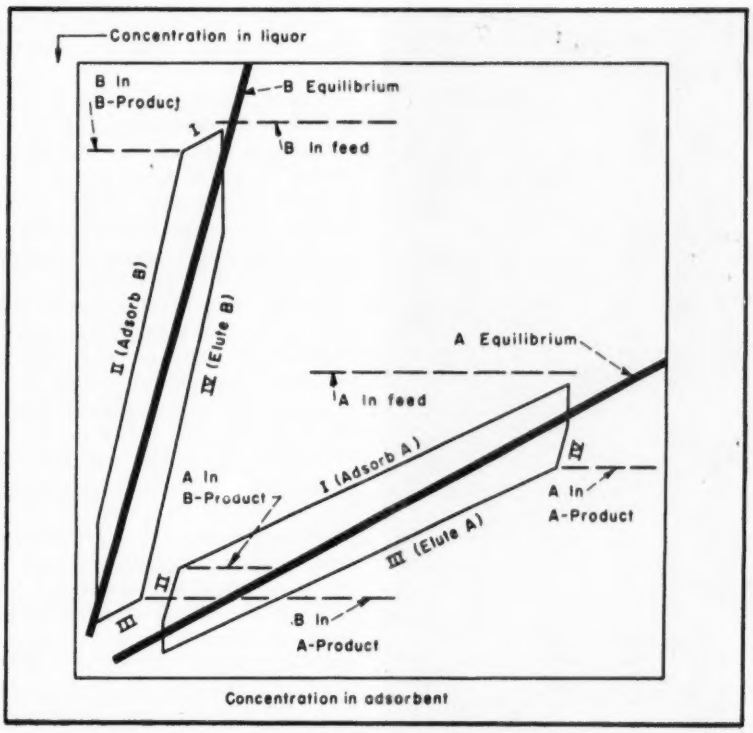


Fig. 4—DESIGN uses equilibrium diagram to relate concentrations in liquid and adsorbent at any cross-section of a continuous contactor.

sorbent material moves in a closed path through four zones countercurrent to a closed liquid path. In Zone I adsorbent, containing *B* and moving countercurrent to feed containing *A* and *B*, selectively adsorbs *A* and carries it into Zone IV. At the end of Zone I a portion of the circulating liquid, now free of *A* but still containing *B*, the less strongly adsorbed substance, is removed from the system. The rest of this solution moves through Zone II where freshly eluted adsorbent removes *B*, essentially the only component present, and carries it back through Zone I to Zone IV (adsorbing *A* from the feed all the while). The circulating solution leaves Zone II free of *A* and *B*, is joined by fresh elutant and moves into Zone III countercurrent to resin containing essentially only *A*. There it desorbs *A* and is, in part, withdrawn from the system; the rest continues into IV countercurrent to adsorbent containing *A* and *B* where it removes more easily desorbed *B* and finally merges with feed solution.

Just as in distillation where a column may consist of a stripping or rectification section alone, so here the complete four-zone cycle need not be used. Adsorbent must move in a closed path but the liquid path need not be closed. Thus a cycle may consist only of Zones I and III, in which case the product containing more strongly adsorbed *A* can never be completely freed of *B* since the adsorbent leaving I is in equilibrium with the feed and carries *A* and *B* into III where they will be eluted together. *B* will, however, be free of *A* although it will contain considerable elutant (carried over from desorption step in III and displaced by feed in I).

In a I, II, III cycle the product containing *A* cannot be freed from *B* but the *B* product will be pure and will contain little elutant (displaced by feed in II and moved to III).

A I, III, IV system will give complete separation of *B* from *A* but again, as in I, III setup, the *B* stream will contain much elutant.

Other variations from the basic cycle are possible. Eagle and Scott[6] described, for hydrocarbon separation, a modified three-zone cycle in which adsorbent was desorbed, first with hot then cold strippant. Hibshman[8] proposed the separation of iso-octane and normal heptane by a modified three-zone (I, III and IV) cycle using pentane as elutant. In this system a portion of the product containing more strongly adsorbed heptane is freed of pentane and returned to zone IV as reflux. Olsen[7] patented similar I, III, IV systems with reflux, especially as applied to aromatics separation, and Rommel[9] patented a four-zone cycle with reflux of elutant-free products to Zones I and IV.

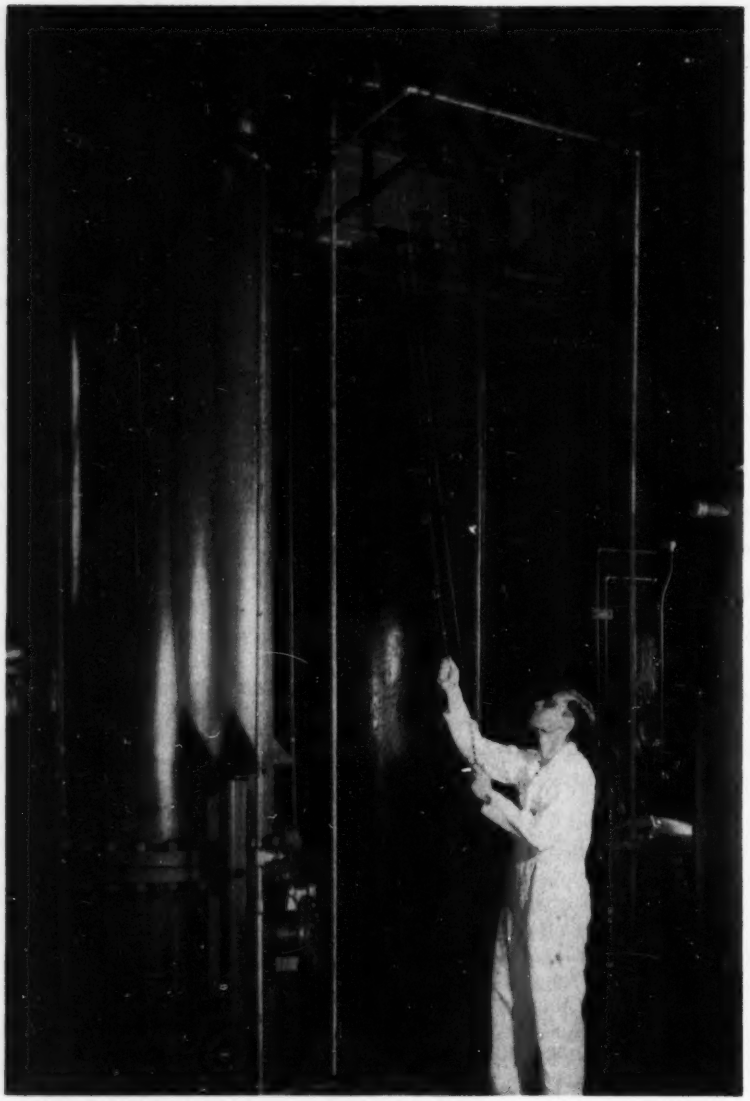
When such a process is applied to the separation of aromatics from saturated hydrocarbons, a portion of feed is first split into its components by distillation and used to prepare resin in zones I and II for adsorption. The choice of elutant is based on two considerations:

- It must be separable from the feed constituents by distillation.
- Since elutant must desorb feed components and in turn be desorbed by feed, its adsorbability should preferably approximate those of the feed components.

How to Design for Countercurrency

Suppose *A* and *B* are to be separated by an isothermal, countercurrent process using an elutant. If data are available a complete equilibrium diagram would express the relationships between the concentrations of each of the three components (*A*, *B* and elutant) in and surrounding the adsorbent, equivalent to isobaric vapor-liquid data required for calculating a ternary distillation system. In addition, the total of the three components adsorbed per unit weight of adsorbent would have to be determined for each composition although this probably will not change much.

The data for such systems resemble distillation data and binary systems can be plotted as familiar *x-y* curves where *y* is the fraction of more adsorbed component in the adsorbed phase and *x* is the fraction of more adsorbed component in the liquid phase (like the more volatile component in the vapor and liquid phases). Numerous binary systems



ION EXCLUSION unit at Dow Chemical's Midland plant.

have been investigated and give, as in distillation, x-y curves which lie entirely above the 45 deg. line, or curves which cross the line as the relative adsorbability reverses, equivalent to azeotropism.

In some cases, as in ion separation and ion exclusion, both of which employ exchange resins as adsorbants, feed is a dilute solution in elutant: water in exclusion separation of glycerine and salt; dilute acid in separation of potassium and lithium ions. For these cases of dilute solution it can be assumed for demonstration purposes that the equilibrium diagram of each component is unaffected by the presence of the others and that concentration of each in adsorbent is proportional to concentration in solution. This is equivalent to Henry's Law in multi-component distillation.

Fig. 4 indicates a method of design where two dilute components, *A* and *B*, are to be separated by the four-zone countercurrent scheme. In addition to the two equilibrium lines, operating lines are shown for each of the four zones, relating concentration in liquid to concentration in adsorbent at any cross section of a continuous contactor. The closed figures formed by operating lines correspond to the closed liquid and adsorbent paths of Fig. 3.

The change in concentration of *A* and *B* in the adsorbent as it moves through the cycle can be obtained by tracing the closed figures in Fig. 4 in a clockwise direction; liquid concentrations, by tracing counterclockwise.

The operating lines are determined by the following considerations:

1. The slope of each line is the ratio of adsorbent to liquid flow in that zone, so the slopes of corresponding operating lines applying to each component are the same (e.g. Zone II line for *B* parallels Zone II line for A).

2. Feed and elutant entrance are represented by vertical lines crossing the equilibrium lines, since at these points concentration in liquid changes abruptly while concentration in adsorbent is unchanged, and transition from adsorption to desorption takes place. *A* and *B* concentration in elutant are considered zero in this case.

3. Each operating line terminates at a point whose ordinate corresponds to a concentration in one of the product eluates.

4. Assuming the same stage efficiency for each component, the number of theoretical stages in each zone must be the same for each component.

How to Equip for Countercurrency

In order to realize a continuous countercurrent operation, the adsorbent must move in a closed path relative to fixed feed, elutant input points and product withdrawal points. Adsorption is very similar to extraction from solids in terms of equipment required. Countercurrent solid-liquid contactors employ moving beds; fixed beds and moving liquid feed and liquid take-off, as in a diffusion battery; solids immersed and conveyed through the liquid; and continuous mix and settle arrangements. Any of these methods can be applied in principle to adsorption.

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8. Rommel, U. S. Patent 2,646,451.

How to Use Short-Cut Statistics

CHECK YOURSELF

How reliable are your estimates of unknown values?
What evidence really exists for your comparisons?

TRY THESE WAYS

Short-cut statistical techniques can give you an objective analysis of engineering data—rapidly.

START IN NOW

You can begin using these techniques right after reading this article—no further training is needed.

F. PROSCHAN and A. R. BABCOCK, Jr.

RAPID statistical shortcuts, requiring little theoretical knowledge of statistics, can help you solve some of your common chemical engineering problems quickly and easily. Equally important, these shortcuts can be learned in almost no time and, since all necessary tables are provided with this article, you can start in using them right away, without any further training or reference.

Shortcut techniques can answer such questions as:

- How reliable is the estimate of an unknown value, when the estimate is based on the average of a set of several observations?
- How conclusive is the observed evidence that two methods, materials, categories, etc. really differ? Can the observed difference be explained on the basis of ordinary sampling or analytical fluctuations?

Why Shortcuts?

Unfortunately, many of the established statistical techniques to handle these common problems require either time-consuming calculations or a great deal of statistical erudition.

In other cases, the basic data may not warrant highly precise treatment. Here again, the shortcut method could be used to replace the more complex operations and yield a satisfactory answer, quickly.

How Reliable Is an Average Value?

How close is it to the true value?
How much error can be permitted?
How often will you be right?

One of the common problems facing the chemical engineer, be he in research, design, production or what have you, is how to determine the uncertainty of a measured value—how close is it to the true value.

Take an inventory control problem. The ABC Uranium Co. has a fellow charged with keeping track of uranium materials. He is required to take a complete monthly inventory of all the uranium present in various forms.

He naturally wishes to determine the uncertainty of each entry on his inventory sheet—in order to realistically evaluate the significance of any unaccounted for material.

Comparing Several Samples

First off, he obtains three independent samples from each tank and has them analysed for the uranium concentration (in percent). In one tank, say tank 7, the percentages are 37.5, 38.5, and 36.4—the average: 37.47.

If the sampling and assaying had been perfect, the three values would have been identical. However, because of unavoidable variations in sampling and analysis, the values display a certain amount of spread or range—here, 38.5 – 36.4 or 2.1. This range reflects the uncertainty of the measurement—the larger the range, the less reliable the average of the measured values.

Since conditions of sampling and analysis are essentially the same, a knowledge of the variability observed in previous months will be helpful. Therefore, he obtains the results of sampling tank 7 during previous inventories.

Month	Percentage Uranium			Range
March	37.5	39.9	37.2	2.7
April	41.5	40.1	42.5	2.4
May	31.6	31.3	32.9	1.6
June	37.5	38.5	36.4	2.1

FRANK PROSCHAN *is manager of quality control for Sylvania Electric Products Inc., Hicksville, N. Y. A. B. Babcock, Jr. is an engineer with the Chemical Div. of the Borden Co.*

These Factors Help Determine the Reliability of Your Average

Number of Sets,	Number of Measurements in a Set, n													
m	2	3	4	5	6	7	8	9	10	12	14	16	18	20
1	6.35	1.30	0.716	0.506	0.399	0.333	0.288	0.255	0.230	0.194	0.169	0.151	0.137	0.126
2	2.43	0.901	0.576	0.433	0.353	0.300	0.264	0.237	0.215	0.183	0.162	0.145	0.132	0.122
3	1.87	0.808	0.539	0.413	0.340	0.292	0.257	0.231	0.211	0.180	0.158	0.143	0.130	0.120
4	1.67	0.767	0.522	0.404	0.333	0.287	0.253	0.228	0.208	0.178	0.158	0.142	0.130	0.120
5	1.56	0.747	0.512	0.398	0.330	0.284	0.251	0.227	0.207	0.177	0.157	0.141	0.129	0.119
6	1.49	0.730	0.505	0.394	0.327	0.282	0.250	0.226	0.206	0.177	0.156	0.141	0.129	0.119
8	1.42	0.713	0.498	0.390	0.324	0.281	0.248	0.224	0.204	0.176	0.155	0.140	0.128	0.119
10	1.38	0.706	0.493	0.386	0.322	0.280	0.247	0.223	0.203	0.175	0.155	0.140	0.128	0.118
15	1.32	0.692	0.488	0.385	0.321	0.277	0.246	0.222	0.203	0.175	0.155	0.139	0.128	0.118
20	1.30	0.686	0.486	0.383	0.319	0.277	0.246	0.221	0.202	0.175	0.155	0.139	0.128	0.118
30	1.27	0.679	0.481	0.381	0.317	0.275	0.245	0.221	0.202	0.175	0.155	0.139	0.128	0.117
60	1.25	0.675	0.478	0.379	0.317	0.275	0.245	0.220	0.201	0.174	0.154	0.139	0.127	0.117
120	1.24	0.672	0.478	0.377	0.316	0.274	0.243	0.220	0.201	0.174	0.154	0.139	0.127	0.117

This table gives a factor C. When you multiply this factor by the average of the ranges of m sets of measurements you obtain the 95 percent limit of error of the average of a set of n measurements. This table was computed from Table 4 of an article by E. Lord appearing in *Biometrika*, 34 (1947).

Now he averages the four ranges to get the average range, R_{AV}

$$R_{AV} = \frac{2.7 + 2.4 + 1.6 + 2.1}{4} = 2.2$$

Next he goes to the above table and finds the factor which establishes the confidence interval C. Where n, the number of measurements in a set, is 3, and m, the number of sets, is 4, C is 0.767. He then multiplies C by R_{AV} which yields the error limit E, 1.69.

He then can state his conclusion with 95 percent confidence: The June average, 37.47 percent, for the concentration of uranium in tank 7 will not differ (in either direction) from the true value by more than 1.69 percent. Putting it another way, the true uranium concentration is somewhere between 35.78 and 39.16.

Where the Truth Lies

At first glance it might seem somewhat surprising that the 95 percent confidence interval for the unknown true concentration of uranium in the tank should turn out to be wider than the range of the three measurements actually observed. In this case the three measurements ranged from 36.4 to 38.5, well within the limits given by statistical calculation based on past comparable experience.

As you can see it is not at all difficult to get three measurements that are all above (or all below) the unknown being measured. In fact the probability of obtaining the second and third measurements on the same side of the unknown true value as the first (assuming unbiased measurement) is clearly $\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$. Therefore, when you make a set of three unbiased measurements you can expect to find all three measurements above or below the true value 25 percent of the time.

Hence, for you to be 95 percent confident of "bracketing" the unknown true value, you should use the statistically calculated interval rather than the observed range of the measurements.

Some Points to Note

Now let's amplify some of the points made above.

First of all, what do we mean by "95 percent confidence"? Well, if you were to use the same table in a variety of similar situations, then 95 times in 100 your conclusion would be correct and 5 times in 100 you'd be wrong. The interval in which the true value is presumed to lie, here 35.78 to 39.16 percent, is known as the "95 percent confidence interval."

Sometimes, of course, you won't have sets of previous measurements available. What happens then? Then the solution proceeds in the same way. The only difference is that you enter the table with m = 1.

One caution. In using the table it must be assumed that repeated measurements would follow the normal distribution curve of statistical theory. This assumption is generally a safe one—we have assumed it in this article. If in actual practice a marked deviation from normality exists, the risks of incorrect conclusion will differ from those given here.

The advantage of this method is the quick, yet fairly accurate, answer —a convenient test of reliability. However, it really doesn't use all the information that is contained in the data.

For the most efficient use of all the information, confidence intervals should be based on the "standard deviation" determined by more involved methods. The loss of statistical efficiency attributable to the shortcut is small, however, for relatively small sample sizes–up to and including 10 measurements.

A similar small loss of statistical efficiency occurs in using the tests based on range which are presented later on. In any case, the loss is generally compensated for by the greater convenience. However, when the decision to be made involves considerable money, the usual, more rigorous statistical methods are recommended.

Summarizing the Method

For convenience, let's summarize the shortcut technique.

Problem: Given m sets of n measurements each, determine the reliability of the average of the measurements.

Solution: (1) Find the range R of each set of n measurements, (2) Average the m ranges to get R_{AV}. (3) With the appropriate values of m and n use the table to find the factor C. (4) Multiply C by R_{AV} to yield E. (5) It can then be stated with 95 percent confidence that the true value will be no further than E (in either direction) from the average of the n measurements.

Critical Departure Values . . . . . For Up to 10 Measurements

Size of Sample, n	Critical value of τ
2	3.157
3	0.885
4	0.529
5	0.388
6	0.312
7	0.263
8	0.230
9	0.205
10	0.186

This table lists values of τ exceeded with probability 0.05.
This table is reproduced with the permission of Professor E. S. Pearson. It appeared in *Biometrika*, vol. 34, pp. 41-67 (1947).

Use These Critical Values for Comparisons . . . . . If You Have More Than 10 Measurements

Number of Sets, m	Number of Measurements in a Set, n								
	2	3	4	5	6	7	8	9	10
1	3.157	0.885	0.529	0.388	0.312	0.263	0.230	0.205	0.186
2	1.161	0.487	0.323	0.246	0.203	0.174	0.153	0.137	0.125
3	0.796	0.370	0.251	0.194	0.161	0.139	0.123	0.110	0.101
4	0.636	0.309	0.213	0.166	0.138	0.119	0.105	0.095	0.086
5	0.544	0.270	0.188	0.147	0.122	0.106	0.093	0.084	0.077
6	0.484	0.244	0.171	0.133	0.111	0.096	0.085	0.077	0.070
8	0.403	0.207	0.146	0.114	0.096	0.083	0.073	0.066	0.060
10	0.353	0.184	0.130	0.102	0.085	0.074	0.065	0.059	0.054
15	0.280	0.149	0.105	0.083	0.069	0.060	0.053	0.048	0.044
20	0.240	0.127	0.091	0.071	0.060	0.052	0.046	0.041	0.038
30	0.193	0.103	0.074	0.058	0.049	0.042	0.037	0.034	0.031
60	0.135	0.073	0.052	0.041	0.034	0.030	0.026	0.024	0.022

The listed values of τ' are exceeded with a probability of 0.05.
This table was computed from Table 3 of an article by E. Lord appearing in *Biometrika*, 34 (1947).

Is Something New Superior to the Standard?

Does a difference really exist?
Is it merely a chance fluctuation?
How conclusive is the evidence?

Another quite common problem in chemical engineering is that of deciding whether a new method, material, piece of equipment or category of any kind is superior to a standard. Perhaps the observed difference is merely the result of a sampling or analytical fluctuation.

In any event, it is necessary to test the observations to determine just how conclusive the evidence really is. Here we run into three situations: Sometimes past data will be available and the sample size will be ten or less, other times we'll have past data and our sample size will be greater than 10, then again we may have no past data at all.

Relying on Past Data

For an example of the first situation, suppose XYZ Co. buys test quantities of a new raw material presumed to be better than that used currently. Analyses of the first seven test lots show a purity (in percent) of: 96.7, 97.1, 96.4, 96.1, 96.6, 95.9, 96.7. Average purity is 96.5 percent and the range is 97.1 — 95.9 or 1.2. Analyses of a great many lots of the standard material have given a purity averaging 96.2 percent. Is the salesman right when he says the new is better?

XYZ concedes that the new material does display a higher average purity, but it does not wish to switch over unless there is conclusive evidence that it is superior. If there's a reasonable doubt, they prefer to stick to the standard.

How can they quickly and reliably reach a decision?

Step by Step

The first step is to compute a measure of the departure of the average purity of the new raw material from the average purity of the standard raw material; this is τ

$$\tau = \frac{X_{AV} - \mu}{R}$$

where X_{AV} is the average of measurements of the new material, μ is the average based on a great many measurements of the standard material and R is the range of measurements for the new material.

Then

$$\tau = \frac{96.5 - 96.2}{1.2} = \frac{0.3}{1.2} = 0.25.$$

The question now is: Is this departure significantly large or is it small enough to be explained by the laws of chance?

The table of critical departure values is checked for the answer. For a sample* size of 7 the critical value is 0.263. This means that the value 0.263 is exceeded by chance only 5 percent of the time.

For example, if a great many batches of the standard material were analyzed and τ calculated for each sample, then 95 percent of these values would be 0.263 or less. Five percent would be larger.

Since the observed value, 0.25, is less than the critically large value, it is concluded that the observed difference between the new material and the standard could have resulted from chance—even if the new material were no better than the standard material. In other words, there is no conclusive evidence of superiority.

In this case the calculated value of τ, 0.25, is quite close to the tabular value, 0.263; therefore, a practical view would dictate an analysis of some more samples of the raw material to make a more reliable decision—especially since the present sample size, 7, is rather small.

For while there is no conclusive evidence of superiority of the new over the standard, neither is the evidence conclusive that there is *not* a superiority.

What Are Your Risks?

Clearly, from the way the table is constructed and the test performed, 5 times in 100, even if the materials did not differ, it would be falsely concluded that a superiority for the new did exist—just from chance variations. Thus, the risk of a false conclusion when the standard and the new are really alike in performance is 5 percent.

What, then, is the risk of a false

*Note that "sample" in statistical terminology refers to a batch of material taken from a larger batch, or a group of items taken from a population of items.

These tests are sharp tools which will aid—but not supplant—the use of common sense.

conclusion when the standard and the new actually differ in performance?

Evidently the risk of not detecting superiority when it exists depends upon the degree of superiority. If the new is just slightly superior to the standard the risk of a false conclusion is just under 95 percent. On the other hand, if the new material is vastly superior to the standard, then practically all of the time the observed value of τ will be larger than the table value, and the risk of a false conclusion approaches 0 percent.

In other words, the risk of failing to detect an actual superiority cannot be specified unless the degree of superiority is also specified.

In practice, experience and common sense would probably have led to the same conclusion as XYZ Co. obtained by statistical analysis. However, the point is that the τ-test of significance described above (and statistical tests of significance in general) represents a sharp tool to aid—not supplant—the use of common sense.

The test permits an objective and reliable decision with a known degree of risk in those doubtful cases where the data do not clearly show a difference one way or the other. You might say that it evaluates quantatively the amount of confidence you should place in the observed difference between the two.

Two Steps to an Answer

For convenience, here is a summary of the method to be used for evaluating an observed difference when past data are available and you have 10 or fewer items in your sample.

Problem: A standard item averages μ for a certain characteristic. A new item is tested to determine whether or not it is superior to the standard item. A sample of n (as high as 10) new items yields an average of X_{AV} greater than μ, and a range of R. (It is assumed here and throughout this article that the larger the characteristic for the item, the better it is. If in actual practice, superiority is associated with smaller values use $\mu - X_{AV}$ in place of $X_{AV} - \mu$. This same procedure holds for subsequent sections.) Is there conclusive evidence that the new item is superior to the standard?

Solution: (1) Calculate τ. And (2) check the table; if the calculated value is larger than the value in the table for the appropriate sample size n, conclude that the new is superior to the standard. Otherwise, decide that no conclusive evidence of superiority exists.

How About Big Samples?

If the sample size were larger than 10, it would not be advisable to use the τ-test because the range of the sample would not be a very efficient estimate of variability. Instead it is preferable to break up the sample into several subsamples, obtain the average range of these subsamples and apply the τ' test using the next table.

For example, a plant engaged in sulfuric acid leaching of ore has been using an oxidant in amounts equivalent to 0.5 percent of the ore weight. Solubilization of the desired constituent averaged 95.25 percent. The development division suspects that greater solubilization can be obtained if the oxidant used were increased to 1.0 percent of the ore weight.

As a test, 22 batches of ore are leached in the plant with all conditions as constant as possible except that the weight of oxidant added is hiked to 1.0 percent of ore weight. Test yields are: 95.8, 95.1, 95.0, 94.9, 95.1, 95.7, 96.1, 95.2, 95.4, 95.9, 94.8, 96.0, 96.2, 94.8, 95.4, 95.8, 96.2, 95.0, 95.6, 95.7, 95.4, 95.9. Average yield is 95.50.

In other words, the 22 test batches using 1.0 percent oxidant averaged 0.25 percent higher in solubilization than did the standard dosage of 0.5 percent of the ore weight. The observed superiority seems large enough to suggest an improvement, yet still small enough to be perhaps explainable as a result of sampling fluctuations. Is the devlopment division justified in recommending that the higher amount of oxidant be added?

Essentially, this problem is the same as the preceding one—except that the sample size is now larger than 10. First step in the solution is to break up the sample into several subsamples of equal size. A convenient grouping here would be three subsamples of seven batches each with the last batch left over.

Taking the first seven, the second seven and the third seven—omitting the batch left over—the average of the 21 batches is $X_{AV} = 95.48$. And the three ranges are 1.2, 1.4 and 1.2. Average range R_{AV} is 1.27

Next calculate

$$\tau' = \frac{X_{AV} - \mu}{R_{AV}}$$

where, as before, μ signifies the long-run average obtained using the standard process. Then

$$\tau' = \frac{95.48 - 95.25}{1.27} = \frac{0.23}{1.27} = 0.181$$

Entering the final table with $m = 3$ and $n = 7$, the critical value of τ' is found to be 0.139. Since the calculated value, 0.181, is larger than the tabular value, 0.139, it is concluded that an increase in oxidant weight *does* boost the solubilization efficiency.

What Is the Best Subsample Size?

A natural question at this point is: In general, what is the best way to break down a sample into subsamples? Statistical theory has shown that using subsamples of 8 batches or entries results in the most efficient estimate of variability calculated from range.

Hence, a good way to break up the sample is into equal subsamples each of a size close to 8, leaving a minimum of observations left over (and therefore unused).

Good Or Bad, Does It Differ?

Notice that in the last two situations the question to be answered was: "Is the new item better than the standard item?" Now if the question were: "Is the new item worse than the standard item?", the only modification in the above procedures is to reverse the algebraic sign of τ and τ'.

Suppose that the question is "Does the new *differ* from the standard?"

For example, suppose a "new" brand of synthetic urea is being tested

for resin glue formulation, and it is desirable to know whether the setting time using the new formulation will differ from the setting time using the standard brand. Note the distinction. In previous illustrations, the new item was expected to be superior to the standard. Here, superiority doesn't matter. What we want to do here is to determine whether a true difference in settling time exists—longer or shorter we don't care, we just want to know "Does it differ?"

The test to be performed (using τ or τ') is called a two-sided test.

For this test the algebraic sign of τ or τ' is disregarded. This doubles the risk of concluding that the experimental and standard items differ when actually they do not—increasing it from 5 percent to 10 percent.

The reason is apparent. In the one-sided case (say, of testing for superiority), a significantly large value of τ or τ' occurs only when $X_{AV} - \mu$ is large enough in the positive direction. In the two-sided case a significantly large value of τ or τ' can occur if $X_{AV} - \mu$ is large enough in either the positive or negative direction. Thus there is twice as much chance to get a significantly large value.

Summary of the Method

Now let's summarize the method for use when past data is available and the sample size is larger than 10.

Problem: As before, a standard sample averages μ for a certain quality characteristic. To determine the superiority of a new item over a standard, a sample of more than 10 new items is measured. Is there conclusive evidence of superiority?

Solution: (1) Divide the sample into equal subsamples of a size as close to 8 as possible that will leave a minimum of leftover observations. (2) Compute the average X_{AV} of the observations. (3) Compute the range of each subsample; average these to obtain R_{AV}. (4) Compute τ' and check it against the value in the table. If it exceeds the tabulated value, conclude that the new item in superior to the standard. Otherwise, decide that no conclusive evidence of superiority exists.

Nothing to Lean On

In some practical problems, no past data is available for either the standard or the new item. In other situations, a lack of control exists, so that the use of past data in comparing the standard to the experimental would be dangerous and misleading. In either case neither τ nor τ' can be used, since their use presupposes a known population average (μ). We then go to the τ'' test.

For instance, a new process for the purification of crude caustic soda is to be compared with the old process. Lack of control has forced us to throw past performance out the window.

A pilot plant experiment is run on 20 batches made by the old process and 20 batches made by the new process—under the same conditions and from the common lot of material. Product purity from each process (in percent NaOH) is

Old Process					Range
98.81	98.86	98.82	98.89	98.80	0.09
98.79	98.87	98.84	98.91	98.80	0.12
98.79	98.81	98.86	98.82	98.90	0.11
98.87	98.80	98.86	98.90	98.81	0.10

Average: $X_{AV1} = 98.840$

New Process					Range
98.86	98.88	98.91	98.90	98.82	0.09
98.92	98.88	98.91	98.85	98.80	0.12
98.86	98.81	98.88	98.83	98.93	0.12
98.88	98.90	98.83	98.82	98.91	0.09

Average: $X_{AV1} = 98.869$

The average obtained for the new process is higher than that for the old process. How significant is the difference?

To answer this, calculate

$$\tau'' = \frac{X_{AV1} - X_{AV2}}{2\,R_{AV}}$$

where R_{AV} is the average of all the ranges in both new and old samples. Thus in this case $R_{AV} = 0.105$ and $\tau'' = 0.138$.

The rest is simple. The computed value of τ'' is compared to the appropriate value in the table for a subsample size $n = 5$, and for the total number of subsamples $m = 8$ (there were 4 subsamples in each of the two samples). This value is 0.114.

Since the computed value, 0.138, is greater than the value given in the table, 0.114, it is concluded that τ'' is significantly large. That is, conclusive evidence does exist that the new process is superior to the old.

Summing Up the Method

Here's a summary of the short cut to use when you've no past data to lean on.

Problem: Given observations on an equal number of batches made by two methods, is conclusive evidence present to show that method "A" is superior to method "B"?

Solution: (1) Divide the set of values obtained by method "A" into subsamples of size n (close to 8); similarly for method "B". (2) compute τ''. (3) Check the computed value against the value of τ'' in the table. If the computed value is larger, conclude that method "A" is better than "B." Otherwise, do not.

Nomenclature

- C Factor for determining the 95 percent confidence interval.
- E $C \times R_{AV}$, the 95 percent limit of error of the average of a set of n measurements.
- m Number of sets of measurements.
- n Number of measurements in a set.
- N Total number of observations for the new material.
- R Range of a set of measurements—the difference between the largest and the smallest in the set.
- R_{AV} Average range of m sets of n measurements each.
- X_{AV} Average of a sample of n measurements for a new material.
- X_{AV1} Average of measurements for method "A."
- X_{AV2} Average of measurements for method "B."
- μ Population average (based on a great many measurements) of the standard.
- τ Measure of departure of the new material average from the standard material average for determining whether the new is superior to the standard. Past data available and the sample size 10 or less.
- τ' Measure of departure of the new material average from the standard material average for determining whether the new is superior to the standard. Past data available and the sample size greater than 10.
- τ'' Measure of departure of the new material average from the standard material average for determining whether the new is superior to the standard. Past data either not available or not reliable.

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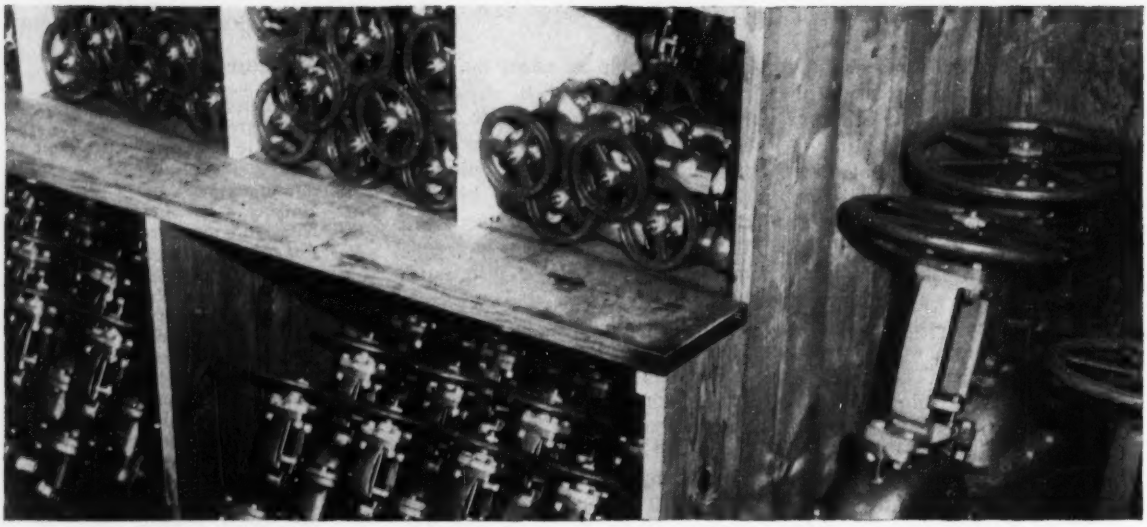


75 Questions and Answers That Will Help You Select Materials for . . .

Valves to Combat Corrosion

Selection of proper valve materials will protect your investment in these high-cost equipment items, and minimize interference with production caused by their failure.

This article is a product of the recent valve clinics sponsored by the Cooper Alloy Foundry Co., Hillside, N. J. These clinics—held in Pittsburgh, Buffalo, Newark, Houston, St. Louis, Chicago, and New York—were attended by over 1,000 engineers concerned with all phases of valve construction and use. On hand to supply the answers to the hundreds of questions submitted was P. C. Shaffer, chief engineer and N. S. Mott, chief chemist and metallurgist.

From these questions and answers, we have selected and classified 75 that had most to do with materials that you would use in valves for corrosive service. The questions selected could not properly be limited only to what valve material is good for what corrosive service. For you have to consider also properties of materials that will make them suitable for valve construction from a mechanical standpoint. Too, there are certain phases of valve operation, installation, repair and fabrication that are directly tied up with the materials used in valve construction and therefore have a definite bearing on the selection problem.

Obviously this article is not intended to completely cover the subject of materials for valve construction. However, we believe you will find it stimulating and useful.

Value of this article will be greatly enhanced by using it in conjunction with the Dec. 1953 *Chemical Engineering* report on Process Piping. This report includes complete yet concise coverage of valve principles and construction features. Helpful also in this connection is the Corrosion Forum presentation on Cast High Alloys in the Oct. 1953 issue.—EDITOR.

What Valve Materials Can Handle These Corrosives?

What alloy do you recommend for **dilute sulfuric acid** solutions?

> **CF-8M up to 40 percent at room temperature, up to 10 percent between 160 and 175 deg. F., and up to 0.75 percent at boiling. With higher concentrations use CN-7MCu.**

Do you know if anyone is developing a better packing than Teflon for valves used 24 times per day in **94-98 percent sulfuric acid** at 40 psi. and 50-120 deg. F.?

> **At present Teflon is most widely acceptable, but other chemically-resistant materials are becoming available.**

What metal do you suggest for **60 to 98 percent sulfuric acid**; also for oleum?

These concentrations would be handled at room temperature by CN-7MCu; at 175 deg. F., by Illium; and at boiling by Hastelloy B or Duriron. Oleum is handled by CF-8M up to 200 deg. F.

Are CN-7MCu valves good for **all concentrations of sulfuric acid?**

CN-7MCu is good for all concentrations at room temperatures. At 176 deg. F., it is good for concentrations below 65 percent and above 85 percent. At boiling, it is good up to 20 percent.

What alloy would you use for **60 percent sulfuric acid and live steam** used together?

Illium is recommended.

Is CN-7MCu resistant to **hydrochloric acid?**

CN7-MCu is normally resistant up to 20 percent concentrations at room temperatures, and up to 2 percent at 175 deg. F.

What metal and valve do you recommend on **muriatic acid** lines in a hydrochloric acid plant?

Hastelloy C would be recommended with gate valves.

What alloy would you recommend for service involving intermittent use of **32 percent hydrochloric and 95 percent nitric acids?**

Hastelloy C or Chlorimet 3 are the only alloys that will stand up to both acids in those concentrations. In the latter acid they probably will not be too good. Durichlor is also resistant but is too brittle.

Do you recommend CF-8M over CF-8 for **oxidizing acids**, particularly **nitric acid?** Our experience is unsatisfactory, especially with the nitrates.

CF-8 is superior to CF-8M in nitric acid at all temperatures up to and including boiling. Low carbon 25-12 alloy, however, is best.

What type of packing would you recommend for service in **caustic solutions, sulfuric acid up to 98 percent,** and high temperature **sour petroleum products?**

Teflon in each instance if the temperature does not exceed 300 deg. F. At much above 300 deg. F., Teflon gets soft and starts to flow, giving a poor seal.

What metals handle **chlorine and caustic?**

Carbon steel or CF-8 will handle dry chlorine. If it is wet, Hastelloy C must be used. Monel is recommended for handling caustic.

What grade of nickel would you suggest for **molten caustic** at 1,690 deg. F.?

Pure nickel is best used to handle molten caustic under most conditions; Inconel if any particular strength condition is to be met.

What metal do you recommend for **hot brine** (up to 180 deg. F.,) **cold brine** (70 deg. F. and under)? What metal for **mercury** lines?

CN-7MCu handles hot brine, and CF-8M will handle cold brine. CF-8 is used for mercury when contamination is to be avoided; otherwise carbon steel is satisfactory.

What is the best alloy for **concentrated sodium chloride and glycerine** solution stressing lowest first cost?

CF-8M is recommended as the lowest cost alloy suitable for this combination.

How does CN-7MCu stand up under **wet sulfur dioxide** between 30 and 80 deg. C.?

CN-7MCu will stand up well.

What metal and valve type do you recommend with **molten sulfur?**

CF-8 would be used to handle molten sulfur in "Y" valves.

How Do These Materials Stack Up for Use in Valves?

Do you have any information on corrosion properties of **titanium-stablized stainless** steels?

Titanium-stabilized stainless is not as resistant as columbium-stabilized material in boiling 65 percent nitric acid, usually used to test such alloys for susceptibility to intergranular corrosion. It is about equivalent in resistance in other media.

Is there any advantage in using a valve of **columbium-stabilized stainless** when properly heat-treated valves are available? What is the

Cast Alloy Compositions Referred to in This Article with Equivalent Wrought Types

Cast Alloy Designation	Wrought Alloy Type*	Composition Percent							
		C Max.	Mn Max.	Si Max.	P Max.	S Max.	Cr	Ni	Other Elements
CF-8	304	0.08	1.50	2.00	0.04	0.04	18-21	8-11	.....
CF-8M	316	0.08	1.50	1.50	0.04	0.04	18-21	9-12	Mo 2.0-3.0
CF-8C	347	0.08	1.50	2.00	0.04	0.04	18-21	9-12	Cb 8×C min., 10 max.; or Cb-Ta 10×C min., 1.35 max.
CN-7MCu†	...	0.07	1.50	†	0.04	0.04	18-22	21-31	Mo-Cu†

* Composition of equivalent wrought types approximately but not exactly the same.
† Several proprietary alloy compositions fall within the stated chromium and nickel ranges and contain varying amounts of silicon, molybdenum, and copper. These are alloys of the "20" designation such as Durimet 20, Cooper Alloy FA 20, Alloyco 20, etc.

difference in cost between valves of columbium-stabilized stainless (CF-8C) and CF-8M?

> Columbium is used as a stabilizer and if the valve is to be welded, it would be advisable to use a stabilized material to lessen carbon precipitation. Cost for CF-8C material would be approximately 5 percent more than CF-8M.

Will the new **ELC stainless** (extra-low carbon stainless) alloys give as good all-around performance and corrosion resistance as columbium-stabilized alloys?

> ELC stainless will provide the same resistance to intergranular corrosion as the columbium-stabilized alloy. Remember, though, less than 0.03 percent carbon is necessary to insure that intergranular corrosion will not take place.

In view of shortages of **columbium**, is **18-8 with titanium** a satisfactory substitute?

> Titanium additions to 18-8 are reasonably satisfactory, but at the present time all the stainless foundries are finding it difficult to get titanium into the metal. The extra-low carbon grade of CF-8 is recommended as the better substitute.

What metal do you recommend to be used in conjunction with **CN-7MCu** where galvanic corrosion might attack it if used alone?

> Galvanic action only occurs when two metals or alloys relatively far apart in the galvanic series are used together. It is worse as the area of the noble metal becomes larger than that of the less noble metal. Best metal to use against CN-7MCu is CN-7MCu itself.

What advantages are anticipated for **V2B?**

> Considerable increase in erosion and galling resistance is expected since it can be hardened to as high as 350 Bhn.

Is there a stainless steel with the welding properties of **CF-8C** and the corrosion resistance of **CF-8M?**

> Extra-low carbon CF-8M fits this description pretty well.

What are the possibilities of using **titanium** for valves?

> Titanium, besides being difficult to cast, is not too resistant to sulfuric acid and hydrochloric acid, having about the same resistance as CF-8M. It's resistance is the same as CF-8 in boiling 65 percent nitric acid. It is, however, very resistant to aqua regia, oxidizing acid chlorides and wet chlorine, in which all of the stainless alloys are very poor.

How do you justify **blue African asbestos** packing against relatively soft stainless steel material?

> We do not recommend pure asbestos for packing. We use an asbestos packing that is impregnated with other materials, such as petrolatum, and finished outside with mica. This type is comparatively soft and pliable and lends itself to compression very readily for stem packing.

It has been suggested to us to use a **packing lubricated with mica** instead of graphite when used against stainless steel. Do you feel this is advantageous?

> We do. For general use, we hesitate to

use graphite in conjunction with stainless steel because, in the presence of moisture, it will set up a galvanic corrosive action.

Is a **Teflon** seat in a gate valve feasible?

Yes, it is feasible but would require a special design.

Have you ever attempted facing with a material such as **Teflon** in small valves?

Yes, but only on an experimental basis.

In what forms is **Teflon** packing available?

Teflon is available for packing in a variety of forms including solid, impregnated asbestos, shredded, chevron and braided.

What progress has been made in using **Teflon** in the packing gland?

Considerable progress has been made in the use of Teflon for stem packing and many types have been tried with some success—the most common at present being a series of rings formed into chevrons that have proved superior to other types from the seal angle and with a minimum amount of friction.

Have you ever used **"S" Monel** for valve trim? If so, were any difficulties experienced in its machining?

This material is exceptionally hard and requires special tools for machining. We have used it satisfactorily, however, on a number of occasions.

What About Problems Met in Valve Operation?

Is the mechanism of **galling** a physical or chemical phenomenon?

Galling is a physical action. In galling or seizure of sliding metals under loads of a certain value, intense local pressure produces plastic flow at the summits of the surface irregularities, resulting in localized cold welding. This adhesion may cause freezing at slow slipping speeds; shearing, dragging or plowing at high speeds. Although friction is not markedly dependent on the metal hardness, adhesion is. Sufficient hardness will prevent galling.

Why haven't hard surfacing alloys come into more use to relieve **galling?**

In hard surfacing stainless steels, corrosion resistance is lost in the base material because the excessive heat produces carbide precipitation. Water quenching from 2,000 deg. F. will correct the carbide condition, but because of the differences in the coefficients of expansion of the hard facing material and the stainless, the facing often will either crack or break off.

Do you ever lubricate your valve packing with molybdenum disulfide or the silicones to prevent **galling?**

No, we don't. The packing has no connection with galling. Sound design prevents the stem from contacting any metal adjacent to the stuffing box.

Can a valve with CN-7MCu disk seated in body of the same alloy be used without danger of **galling?**

No. This alloy tends to gall as do all the stainless alloys.

Do you manufacture a non-lubricated plug valve? If so, how is metal-to-metal **galling** overcome?

We make such a valve, but the galling problem, to be perfectly frank, is the customer's headache at present. Cocks have to be operated by someone who is entirely familiar with opening and closing them. The operation consists of loosening the nut on the bottom, raising the plug off its seat, then turning very carefully and tightening up the nut on the bottom. This can be done only in specific cases under pressures as the plug will not be tight when lifted off the seat. Non-galling plug valves using a V2B plug are now available.

Does electropolishing tend to reduce **galling?**

Yes, since anything that produces a smoother surface lessens the tendency toward galling.

Is there any material, with some corrosion resistance, that can be used for retaining nuts without danger of **galling?**

We use valve metal (brass 85-5-5-5) for yoke nuts in all our standard valves. This lessens the danger of galling. Since it is an external member subject

only to corrosion from the atmosphere, it usually has sufficient resistance.

Does **galling** occur as often in Monel and nickel as it does in stainless?

Yes. Monel and nickel are as susceptible to galling as the stainless alloys.

Do you consider the use of stainless materials of different hardnesses effective in preventing **galling** when used in contact?

A differential of 50 or more Brinnel points between working parts is effective in lessening tendency to gall. The corrosion resistance of the hardened member is generally lowered and can cause trouble in severe conditions. The answer to galling seems to be in new hardenable corrosion-resistant alloys like V2B.

What thread lubricant and/or material combinations would you recommend to prevent stud **galling** in 950 deg. F., 600 psi., heavy hydrocarbon service?

Molybdenum disulfide is gaining popularity as a non-galling lubricant, and has done a good job preventing stud galling.

Where corrosion is not severe, wouldn't nickel cast iron result in reduced **galling** and lower cost?

This material is relatively hard and would reduce galling, but it could not replace stainless in corrosive applications. No conflict exists here since it would be economically unsound to use a stainless valve where a cast iron valve is satisfactory.

Have you observed **distortion or creep** in nickel valve bodies that result in bonnet leaks or leaks past the disk of gate valves? If so, what has been done about it? If not, how do you avoid it?

The condition of creep in valves of nickel has not been called to our attention, but at elevated temperatures it can happen. Design of disks should compensate for this creep and prevent leaks past the disks. With the ball and socket design, the disks go with the body in any direction and should remain tight at all times.

What type material would be recommended where a **valve is used as a cutting valve**—where it is used partly-opened to open and then close in sulfate solution, hot and abrasive?

Sulfate solutions, hot and abrasive, are resisted well by V2B.

What type of valve do you recommend for **handling abrasive slurries** without line or valve blockage?

A "Y" valve with renewable Teflon disk if your temperature does not exceed 300 deg. F.

What is the reaction to aluminum handwheels? We are troubled with **breakage** because our maintenance people use "persuaders."

Take the persuaders away. Properly-designed valves have large handwheels and rotating-type ball and socket disks so they can be closed with one hand. Wrenches are not needed and they should not be permitted because excessive tightening induces galling. Generally speaking, large handles are preferred. If you're troubled with breakage of aluminum handwheels, we suggest you order malleable iron.

For corrosive service where **long time shutoff** is required, which is more desirable; a hard disk such as Stellite, or a soft disk such as Teflon?

Service conditions dictate the most desirable disk material. Where temperatures permit, a soft disk generally provides more positive shutoff.

We are wondering about bronze **yoke nuts that can melt out** during a fire and allow the valve to open. Are these nuts available in stainless?

They are, but we do not recommend their use because of possible galling. Pure nickel nuts are available that will stand 2,000 deg. F. and won't gall, or the nuts can be made in special stainless alloys that will minimize galling tendencies. Bronze nuts are satisfactory to 1,700 deg. F.

Are columbium stabilized castings ever **magnetic?**

Yes. Columbium is a ferrite former and will help promote magnetism. If the composition balance is such that the alloy is nearly magnetic, a columbium addition may make it positively so.

Since it was stated that **slight magnetism** in CF-8M cast stainless does not indicate an inferior product, I should like to know if a greater degree of magnetism would indicate improper composition and possibly foretell failure in service?

Since the degree of magnetism bears a direct relationship to the chemical

composition, cast 316 stainless that is highly magnetic might be unsatisfactory due to off analysis.

Is there any guide that will indicate when **too much magnetism** is present in CF-8M?

There is a chart available that enables you to estimate the amount of ferrite in the alloy. Using the guide that at least 5 percent is beneficial to prevent intergranular corrosion and that 10 percent is the maximum for satisfactory service, it becomes a rather simple job to check the material.

What to Look Out For During Installation and Repair of Valves

What **electrode materials** do you recommend **for repair** of stainless steel valves?

Since the corrosive handled determines the alloy used for the valve, whenever possible use the same alloy electrode.

Are there any suggested methods for **welding** CF-8 in the field? Must **heat treatment** always follow welding?

Base metal and electrodes must be stabilized with columbium or titanium, or must be of the extra-low carbon (ELC) grade, if post-heat treatment cannot be applied.

What are the **heat treatment** specifications recommended after **welding** alloy CN-7MCu and CF-8M?

When these alloys are welded, the post-heat treatment consists of heating to 1,950–2,050 deg. F. for one hour followed by water quenching.

Is it necessary to post **heat treat** CF-8M if Heliarc **welding** is used?

Yes. The degree of carbide precipitation depends on the carbon content and the time and temperature of heating, and these factors are comparable in Heliarc and metal-arc welding.

How would you **weld** nickel to steel?

Nickel can be welded to mild steel by the arc method using No. 141 nickel or No. 140 Monel electrodes.

How would you **weld** Monel to carbon steel?

Monel can be welded to carbon steel by the arc method using No. 140 Monel electrode or No. 132 Inconel electrodes.

To what temperature should CN-7MCu be **preheated before welding?**

Weld at room temperature using small electrodes and maintaining a 200 deg. F. maximum interpass temperature.

What **welding** procedure would you suggest for installing a nickel valve for molten caustic service?

For caustic applications, arc welding using No. 131 nickel electrodes is suggested.

Does **resurfacing of seats** by machining have any effect on corrosion resistance of CN-7MCu gate valves?

Resurfacing by mechanical means has negligible effect on corrosion.

What is recommended in **valve inspection?**

Frequency of inspection depends on the medium, valve type and frequency of operation. It is suggested, however, that valve inspection be tied in with some existing routine function of the maintenance department.

How Do These Fabricating Procedures Affect Valve Quality?

Does **casting** produce any difference in the corrosion resistance of the same alloy as compared with other forming procedures?

If you bear in mind that the smoother the surface, the less opportunity for corrosion, it might be stated that the rolled or extruded materials have surfaces that are more "stainless." However, the inherent corrosion resistance is based on composition—and there is little if any difference in corrosion resistance between cast and wrought stainless.

Can you cast Type 321 stainless? What are your difficulties in **casting** this alloy? Do you cast 25–12? Do you find it difficult?

In pouring castings of Type 321, there

is a tendency for titanium to fade during extended pours. The cause and remedy for this fading is being investigated by the Alloy Casting Institute. 25–12 alloy is cast regularly without any difficulty.

Do you have any trouble **casting** CF-8C?

No, it is cast without difficulty.

You mentioned a standard heat treatment of a quench from about 2,000 deg. F. Have you attempted to use the 1,650 deg. F. anneal?

As we understand it, quenching from the lower temperature tends to disburse the carbides and sets up greater danger of intergranular corrosion. This anneal has been used for CF-8C but there is no apparent advantage.

We have sometimes thought that 2,000 deg. F. is too high during **heat treatment,** and we have reason to believe that a lower temperature held longer might give better corrosion resistance. Have you any comments?

Carbides in 18–8 will, given sufficient time, go into solution at as low as 1,600 deg. F. However, they will also reform very rapidly just below this temperature. When castings are transferred from the furnace to the quenching tank they lose heat rapidly. Unless they are sufficiently hot to avoid going below the carbide formation temperature during transfer, full heat treatment will not be accomplished.

Are any of the **case hardening** processes of value for stainless valves, stems and seats?

Various methods of surface hardening of stainless are available for valve parts but we do not recommend them in cases where corrosion is of prime importance. Hardening processes invariably lessen the corrosion resistance of the material hardened.

What **hardening treatments** are suitable for Monel and nickel?

Ordinary Monel and nickel are not hardenable. "S" Monel, a silicon bearing Monel, can be hardened by heating for 3 to 4 hr. at 1,100 deg. F., followed by furnace cooling.

Please explain **beryllium hardening** with respect to increased corrosion registance in 275 deg. F. and up, 45–60 percent sulfuric acid?

Our method creates a new alloy similar in basic composition to CF-8 but with greater galling and erosion resistance. Its corrosion resistance is equal to or better than CF-8M. This new alloy is superior to CF-8M in resistance to sulfuric acid, but not as good as CN-7MCu. At 275 deg. F. and up, the atmospheric boiling point of this strength sulfuric is exceeded. Here not even CN-7MCu is suitable and Hastelloy B must be used.

Do the **finishing** operations provide a completely rustproof surface?

The finish is a combination of mechanical cleaning, pickling and—when required—electro-polishing. Generally speaking, it produces a completely passivated surface which is entirely free of contaminants that are liable to cause rusting.

One of the causes listed for rust formation on stainless castings is the fact that particles from shot blasting were left on the surface during the **finishing** operation. Will wire brushing remove these particles and eliminate the rusting?

Generally speaking, if you wire brush with stainless wire brushes, you will be able to satisfactorily remove the particles that are left on after shot blasting with steel shot. However, in most cases, it is more economical to remove the iron contamination by immersing in a solution of nitric acid.

During **finishing,** can anything other than nitric or hydrofluoric acid be used to passivate stainless steel equipment where use of these acids is precluded by the hazards of handling them?

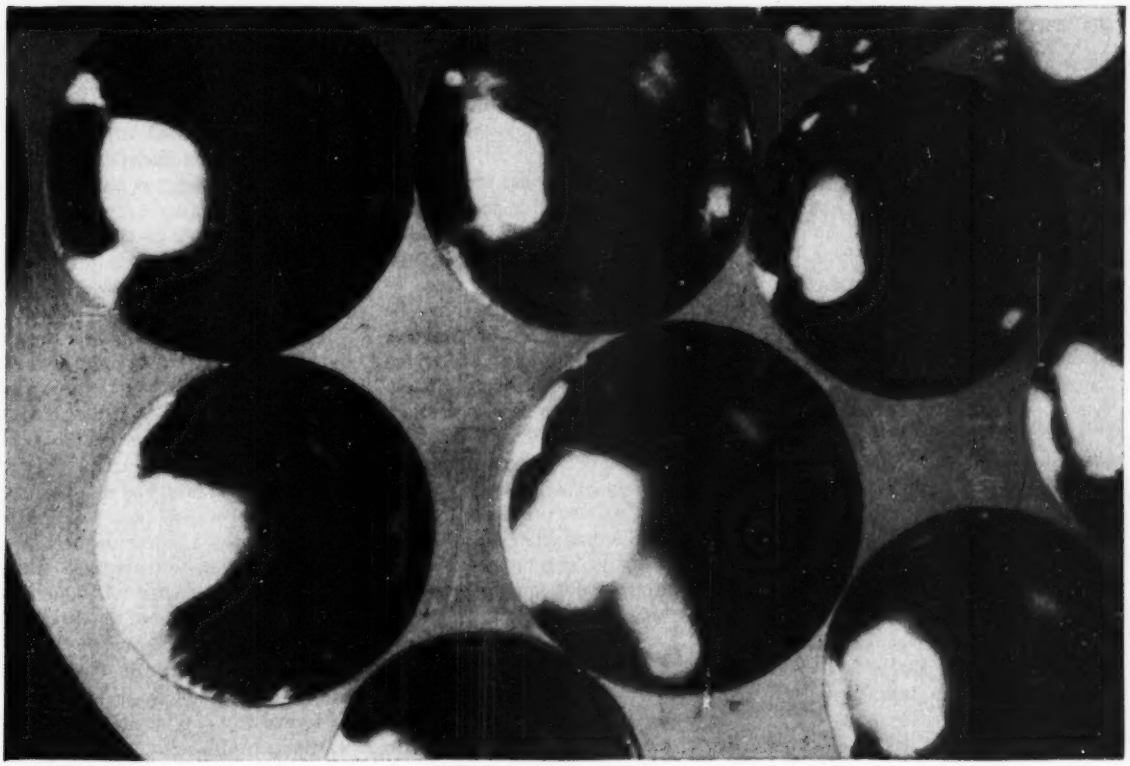
Stainless steel is usually pickled by the use of nitric and hydrofluoric acids, and passivated by the use of nitric acid alone. Hot solutions of chromic acid may also be used to passivate stainless.

Could you go a little deeper in the purpose of passivating during **finishing?**

Stainless steel will in time acquire a passivated surface in air. However, immersion in hot nitric acid will accelerate this. It will also clean the surface of iron contamination. Passivity of surface is necessary in stainless steel for high corrosion resistance.

Does the passivating step of the **finishing** operations increase corrosion resistance materially?

Yes. Many types of so-called "stainless" alloys depend almost entirely on surface passivity for their corrosion resisting properties.



HIGH POROSITY exchange resins for water deionization systems; one of three new techniques to help you . . .

Get Rid of Fouling in Ion Exchangers

- **One way—use highly porous resins in the exchanger.**
- **Another way—cleanup the fouled resin by chemical treatment.**
- **A third method—chemically pretreat the raw water feed.**

F. X. McGARVEY and A. C. REENTS

If you use ion exchange systems for deionizing surface waters or water containing organic wastes — you've probably run into this problem:

Just after the system was put in, everything worked fine. A high quality effluent was produced. But after a short time, the effluent quality started to drop, until it was substantially below the expected value.

What's the cause of this drop in effluent quality? It is due to organic fouling of the resin; resulting in an inability of the anion resin to absorb appreciable quantities of water-soluble organic materials. These organic materials are present as large ions in the water supply.

To avoid or correct this situation, we've found that one or more of the following steps are necessary:

1. Use an ion exchange resin of greater porosity, which will remove large organic ions and release them when regenerated.

2. Use a clean-up procedure to rejuvenate the resin. Acids, alkalies and oxidizing or reducing agents have proved effective.

3. Use a water pretreatment technique. Chlorination is an effective method of eliminating troublesome organic materials in the raw water, before ion exchange.

This whole problem of organic fouling is not confined to any one type of deionization system. In addition to weak base anion resins it has occured in strongly basic quaternary type anion exchanges. And in either multiple bed or mixed bed installations.

Mixed bed systems, with anion resins, which could normally produce water having a resistivity in the range of 5 to 10×10^6 ohms-cm., have been

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found to deliver water having a resistivity of only 5 to $7x10^6$ ohms-cm. Also, the pH of the effluent would be about one unit less than the value obtained with well water.

Similar, though less marked reductions have also been noted in the performance of two and three bed deionization systems. Because these systems normally produce water in the 1 to $5x10^6$ ohms-cm range, the reduction in the quality of the effluent is smaller.

WHY LOSS IN WATER QUALITY?

It has only been recently that the cause of losses in quality—and means for correction of the situation—have become known.

Commercially available anion exchange resins have a limited capacity to absorb large ions — particularly those having a molecular weight greater than 250. Large ions leak rapidly through the resin bed, well ahead of other ions.

This organic leakage largely accounts for lowered effluent resistivity. The most careful analytical procedures do not reveal the presence of inorganic ions.

Previous research by other workers supports this conclusion. Kunin and Myers[5] have reported on the effect of ion size on anion exchange. Gregor[3] and Kressman[6] have shown that ion separations can be made on the basis of ionic size. Hale and others[8] have studied the effect of large ion pick-up on polystyrene-based cation exchangers. They reported that quaternary ammonium ions diffuse into the resin at rates which were inversely related to their molecular weights. The pH of the solution was also found to have an influence on the completeness of exchange. Furthermore, they found that highly cross-linked resins lose cross-linkage and swell irreversibly when fully exhausted with large ions. The exchange of other ions was found to be retarded by the exchange of large ions.

HOW LARGE IONS EFFECT EXCHANGE

Before describing the corrective procedures which have been applied to problems in the field, some information about the difficulty of exchanging large ions should be presented. A fully satisfactory explanation must also account for the irreversible nature of the exchange on the anion resin as well as an irreversible swelling of the cation resin.

Although no theory has yet been developed to answer all aspects of the problem, a simple qualitative explanation can be given based on well-known ion exchange principles.

The size of the ion which can be exchanged is limited by the pore size of the resin. In this case, pore size is the space available in a three dimensional network for an exchanging ion. Surface area plays only a minor role in the exchange of large ions—although, in some cases, the only capacity available may be on surface groups. Commercially available exchangers are relatively highly cross-linked and have limited capacity for ions greater than 250 in molecular weight.

THE EFFECT OF DIFFUSION

When large ions do exchange on the surface of these materials, they have a tendency to diffuse slowly into the resin structure. Materials which diffuse slowly into a resin structure will diffuse out equally slowly.

It therefore is exceedingly unlikely that usual regeneration, which takes a relatively short time, can free the resin from these fouling ions which have been diffusing inwardly for a much longer time. In addition, polyfunctional ions have considerable affinity for the exchangers so that it is not easy to remove them by the usual regeneration.

Physical adsorption may play a role with some of these compounds. It is also possible that polymerization condensation reactions, which are catalyzed by the exchanger groups, may take place and lead to the formation of large resinous bodies trapped inside or on the ion exchanger surface.

WHY POROUS RESINS?

One solution to this problem is to modify the porosity of ion exchange resins by varying the degree of cross-linkage. Several slightly cross-linked resins have been developed. They have a porosity large enough to permit the adsorption of ions having molecular weights in the range of 1,000.

Large ions diffuse more rapidly into these resins than into their highly cross-linked homologues. These exchangers should reduce large ion leakage and should be more easily regenerated. It is true that large ions can diffuse farther into the resin structure so that the exchangers may become seriously fouled after long use. However, since they are regenerated more easily than the highly cross-linked exchangers, a net compensating effect may result.

It is argued that as large ions force their way into resin structures, high pressures will be created which may rupture chemical bonds in the reinous structure. The pressure required to rupture chemical bond is quite large but may be approached by osmotic pressures in the exchange zone. Hale et al[8] reported a reduction of 4 percent in apparent cross-linkage when studying the exchange of tetraethyl ammonium ions on a sulfonated polymer of styrene divinylbenzene (15 percent DVB). The extent of exchange was about doubled by increasing the pH from 7 to 12. This dependency on pH is probably due to adsorbtive forces.

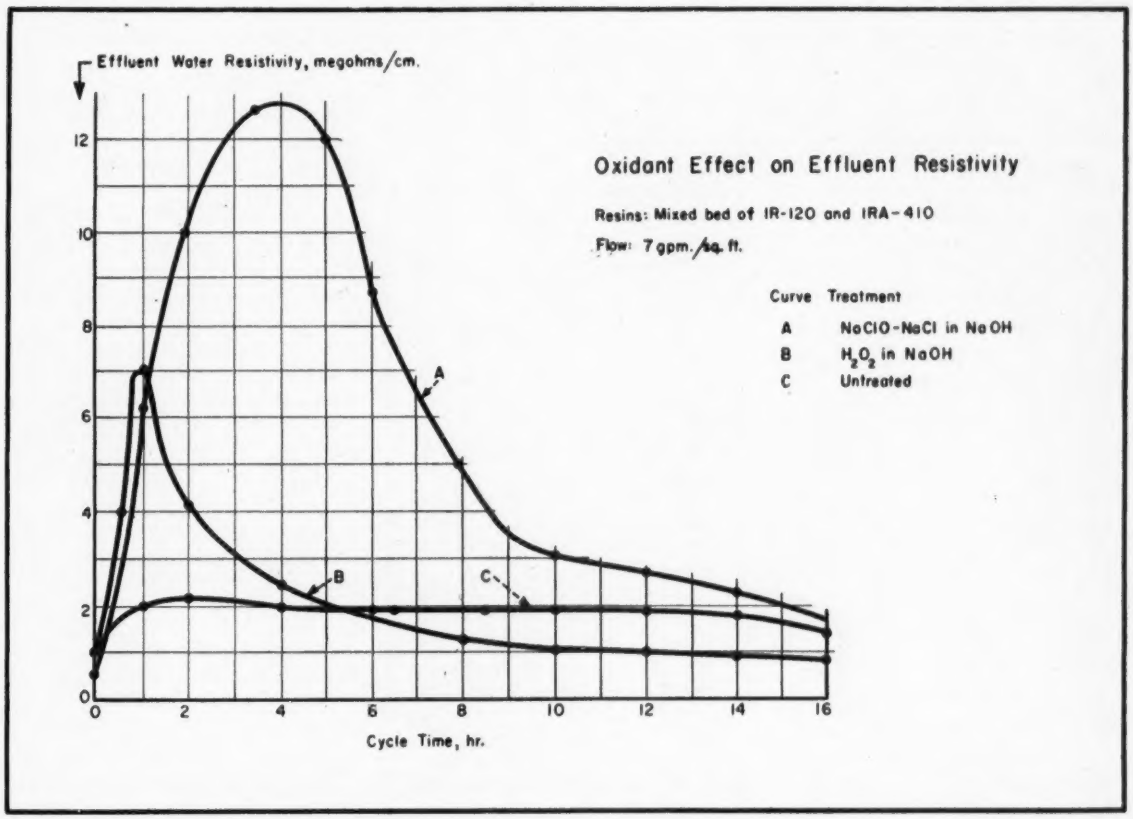
A TYPICAL EXAMPLE

An example of a deionization system in which the substitution of more highly porous resin gave much improved results is this:

The system consisted of a cation exchange unit containing Amberlite IR-120, followed by an aerator, and a mixed-bed unit, containing Amberlite IRA-400 and IR-120. The influent water was drawn from a surface supply. With this system, the resistivity never exceded $1.5x10^6$ ohms-cm.

Another factor generally associated with the large organic ion problem was given particular attention in this instance. The effluent pH from the mixed-bed deionizer was found to be in the range of 5.5 to 5.8. When organic acids are not present, the pH is usually 6.5 to 7.0. Mineral ion removal apparently was not affected. The deionized water did not contain sulfates, chloride bicarbonates, or silicates in any greater amount than was normally found in the effluent of a mixed-bed operating with organic free water.

The anion resin was removed, and Amberlite IRA-401, the porous version of the resin, was substituted. With this porous resin, used along



with the original IR-120, resistivities averaging 10×10^6 ohms-cm. were obtained. The pH of the effluent was 6.8. Operation has been entirely satisfactory since this change.

WHY CLEANUP CAN BE HELPFUL

For many years, workers in the field of ion exchange have attempted to rejuvenate anion exchange materials. Until 1949, these anion exchange materials were of the weak base type, and were relatively unstable to chemical treatment. The methods employed to rejuvenate these early materials could be applied easily and with more assurance to the strong base exchangers developed in 1949, since these later exchangers are stable chemically to oxidizing and reducing agents in dilute solution. Some of the following treatments have been applied:

1. Rinse with sulfuric and hydrochloric acids, at concentrations varying from 2 to 30 percent.
2. Rinse with alkalis such as sodium hydroxide, sodium carbonate, and ammonium hydroxide at concentrations of 2 to 20 percent.
3. Treatment with reducing agents such as sodium sulfite, sodium hydrosulfite, and nascent hydrogen.
4. Wash with salt solutions of 5 to 15 percent concentration using sodium chloride or sodium sulfate.
5. Treatment with mild oxidizing agents such as hydrogen peroxide and sodium hypochlorite.

DRASTIC ACTION NECESSARY

The amount of organic material adsorbed or exchanged by ion exchange resins is undoubtedly quite small in comparison with the total anion capacity. However, many of these organic materials are held quite tenaciously and are not completely removed by the usual hydroxide or acid regeneration.

Once the resin structure has been fouled with large ions and/or their condensation products, rather drastic treatments may be required to free the exchanger of these materials. Since the hydrocarbon structure of the exchanger is quite inert chemically, it should be possible to remove the more highly reactive organic groups by chemical treatment.

Both oxidants and reductants should be considered and both may be required. Dilute solutions of hydrogen peroxide and sodium hypochlorite have been used for this problem. The reduction of complex aldehydes to their alcohols by sodium hydrosulfite has been proposed. These reagents will free the exchanger structure of organic matter by breakdown of the contaminant into smaller groups which can diffuse easily from the resin particle. Such treatments have been used successfully in many field operations.

HOW CLEANUP WORKS

An example of a fouling problem that was solved by resin cleanup involved a mixture of Amberlite IRA-410 and IR-120. Conventional cleanup procedures using acids, alkalis and

salts were ineffective. Next a mixture of 3 percent hydrogen peroxide and 3 percent sodium hydroxide was tried. After 12-hour contact with this solution, the resins were placed in a pilot mixed-bed unit, backwashed and regenerated.

The column was then operated on a raw water containing dissolved organic ionized materials. Average resistivity was raised to about 6×10^6 ohms-cm. for a period of one hour, and thereafter decreased.

This indicated that sufficient organic material was removed to reactivate some exchange groups so that removal of organic acids was again possible. However, in order for the treatment to be practical, the resins should have produced a water of high resistivity for a much longer time. Two additional cycles were made using the hydrogen peroxide treatment, but in this particular instance, no better results were obtained.

IMPROVEMENT WITH CLEANUP

The next type of treatment used was 10 percent sodium chloride-3 percent sodium hypochlorite solution. The same resins were employed as above. The solution was left in contact with the resins for a period of 12 hours. After this treatment, the resins were placed in the small mixed-bed unit and regenerated. With three hours of operation, the resistivity rose to 14×10^6 ohms-cm. A total of three cycles were made, using this treatment.

Specific resistance readings of from 8×10^6 to 14×10^6 ohms-cm. were recorded. This was a definite improvement over previous methods of operations and was chosen as the most promising cleanup procedure for this particular water. The results of the hydrogen peroxide and sodium hypochlorite cleanup procedures are shown. Time of operation is plotted against resistivity of the effluent water.

Good temperature control is essential when the bed perfomance is evaluated with resistance readings. The most suitable technique for controlling deionization quality is by the combined measurement of resistivity and pH. Silica concentration should also be checked frequently, since the presence of silica does not appreciably lower resistivity values.

Typical Problem

A field unit was installed with weak base anion exchange resins and a sulfonic type cation exchanger, in a two bed system. The unit was designed to deionize raw water during part of its cycle. And then deionize recirculated rinse water.

When raw water was in process, conductivity readings showed residual salts of about 5 ppm. as NaCl. A pH of 5.5 was recorded for the effluent.

However, when deionization of recirculated rinse water began, the effluent water pH dropped to about 3.9. Conductivity readings showed an ion concentration in the effluent of 20 ppm. When raw water was again passed through the exchanger, the pH and conductivity readings became normal.

The difficulty was traced to the presence of an organic acid, probably a lignin derivative. The weak base anion resin would not exchange this acid, even though it was dissociated. Molecular weight of the acid was very high, hindering diffusion through the resin particles.

The organic acid was eliminated by pretreatment of the rinse waters. After that, operation of the exchanger system became normal.

WHY YOU NEED A PRETREATMENT

The third possible solution to large-ion fouling—in addition to the use of large-pored resins and resin cleanup—is chemical pretreatment of the water supply.

Obviously, it would be helpful to be able to identify exactly the organic materials that cause contamination. But unfortunately these materials are very complex and usually occur in mixtures that are difficult to separate. Contaminants can be expected to occur in surface waters from decaying vegetable matter and would contain hydrolysis products from the cellulose structure of wood; pigments and fibrous fragments from bark and leaves; and proteinaceous materials from animal life.

Initial treatment would remain colloidal and suspensoid substances, and only truly soluble materials would reach the resin bed. Many of these are nitrogenous compounds, which, as reported by Taras[8], are highly complex and amphoteric. You would, therefore, expect to encounter compounds with amino acid properties as well as polysaccharides and partially oxidized sugars.

In the field it is particularly difficult to make a quantitative analysis of organic materials present. Color index and chemical oxygen demand—about the only convenient field tests—are shown by Nordell[6] to be unrelated to each other.

In some cases the amount of oxygen consumed may be greater for slightly colored waters than for highly colored ones. Nor can color be used as an index of the total amount of organic matter present, although color does definitely indicate the presence of some organic material.

PRETREATMENT BY CHLORINATION

Color bodies in water are known to be one of the factors that influence the operation of strong base anion exchange resins. This color is relatively easily removed by coagulation, sedimentation and filtration. This treatment is well known, having been reported many times in the literature. However, despite coagulation and filtration, "before-and-after" oxygen-consumed tests showed that some organic ions still remained in the water.

Chlorination is one of the methods employed for eliminating organic bodies by oxidation. The process of so-called "super-chlorination"—with one to four hours retention—is probably the most satisfactory. Other oxidants such as hydrogen peroxide, potassium permanganate, and ozone can be used. But their cost and problems in handling must be considered carefully.

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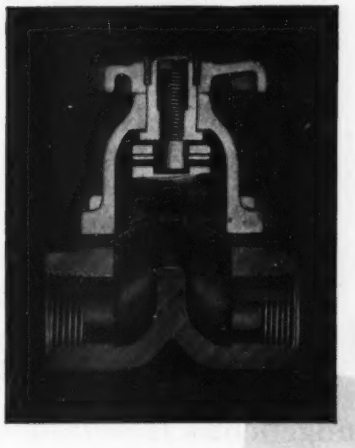

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Hydrochloric acid, conc. (10%)	Good	Excellent
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Acetone	Good	Fair
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Benzene	Unsuitable	Fair
Xylene	Fair	Good
Lubricating Oil	Unsuitable	Excellent
Calcium chloride, 15% aq.	Excellent	Excellent
Calcium hypochlorite	Excellent	Excellent
"Duponol" ME, 10% aq.	Excellent	Excellent
Triethanolamine	Excellent	Good
Camphor Oil	Unsuitable	Excellent
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Saturated salt water	Excellent	Excellent

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Chemical Engineering Fundamentals

Kinetics of Homogeneous Reactions—II

THOMAS E. CORRIGAN, Research Engineer, Mathieson Chemical Corp., Brandenburg, Ky.

Last month we outlined a procedure for determining the order of a reaction and included a tabular summary of rate equations (*Chem. Eng.*, Aug. 1954, p. 208). In this second installment on the kinetics of homogeneous reactions, we'll start by working out some problems involving order of reaction and the calculation of reactor size. Then we'll consider complex reactions including some sample calculations.

Problems Involving Order of Reaction

Problem—Determine the order of reaction and the rate constant for the reaction

$$A + B \longrightarrow R + S$$

The initial concentrations are: $C_A = 0.564$ moles/liter and $C_B = 0.311$ moles/liter. Conversion data are as follows:

Time, t (min.)	Conversion, x (moles/liter)
0	0
6.55	0.077
11.15	0.117
16.82	0.153
21.5	0.176

Solution—Since the equation has a molecularity of two, we will first guess that the reaction is second order. The assumed equation would be: $dx/dt = k(a-x)(b-x)$. The integral form of this equation is:

$$[1/(a-b)] \ln [b\,(a-x)/a\,(b-x)] = kt$$

Thus, a plot of

$$[1/(a-b)] \ln [b\,(a-x)/a\,(b-x)]$$

vs. t should give a straight line. Since a and b are the initial number of reacting molecules,

$$a - b = 0.564 - 0.311 = 0.253$$

$$1/(a-b) = 1/0.253 = 3.96$$

t	x	$a-x$	$b-x$	$b\,(a-x)$
0	0	0.564	0.311	0.1755
6.55	0.077	0.487	0.234	0.1518
11.15	0.117	0.447	0.194	0.1390
16.82	0.153	0.411	0.158	0.1279
21.5	0.176	0.388	0.135	0.1206

t	$a\,(b-x)$	$\frac{b\,(a-x)}{a\,(b-x)} = f$	$\log f$	$\frac{2.3 \log f}{(a-b)}$
0	0.1755	1.000	0	0
6.55	0.1320	1.150	0.061	0.709
11.15	0.1094	1.268	0.1035	1.205
16.82	0.0890	1.435	0.158	1.835
21.5	0.0760	1.582	0.200	2.320

Fig. 1 is a plot of the last column of calculated values vs. time in minutes. You will note that 2.3 log $f/(a-b)$ is the same as

$$[1/(a-b)] \ln [b\,(a-x)/a\,(b-x)]$$

Since the plot is a straight line, we have guessed correctly that the reaction is second order. The rate constant is the slope of this line; $k = 0.107$ liters/mole-min.

Problems Involving Reactor Size

Problem—The reaction A going to R takes place in the gas-phase in a batch reactor and is non-reversible. When the temperature is 500 R. and the pressure is 1 atm., 21.5% is converted at the end of one hour. At the same temperature but at 2 atm. pressure, 35.5% is converted in one hour. What would be the percent converted in one hour at 6 atm. and 500 R.?

Solution—Use as a basis of calculation the volume of

Nomenclature (Consistent units)

a, b, c	Number of reacting moles of a, b, c, etc.
A, B, C, D, E	Reactants
C_A, C_B, C_C	Concentration of A, B, C, etc.
C_{A_0}	Initial concentration of A
C_{A1}	Concentration of A, increment 1
d	Differential operator
e	2.7183
I	Constant of integration
k	Rate constant
k'	Rate constant, reverse reaction
K	Equilibrium constant
r, r_f, r'	Rate, forward rate, reverse rate
t	Time
x	Conversion
Δ	Finite change in a property

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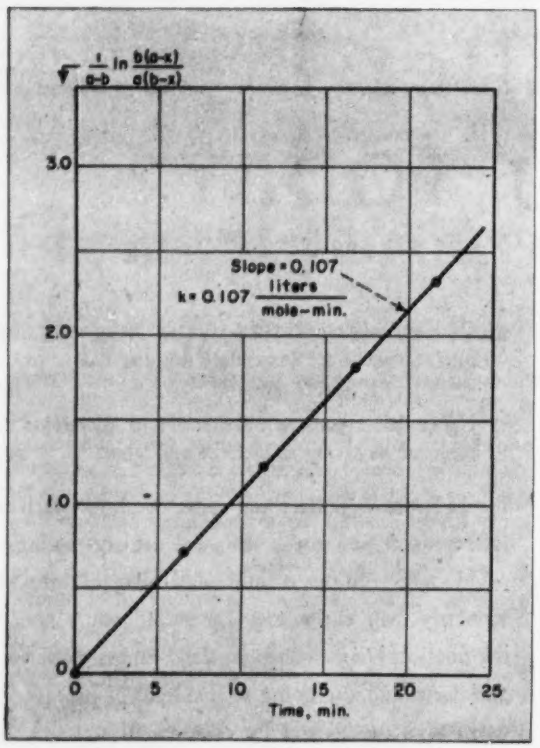

Fig. 1—Straight line proves reaction is second order.

reactor which will contain 1 lb.-mole of gas. Since this is a batch reaction we will use concentrations and express our rate equations in terms of concentrations.

The first step is to find the proper rate equation and evaluate the constant. The second step is to use this rate equation to determine the conversion at the last set of conditions.

Let's assume that the reaction is first order:

$$-dC_A/dt = kC_A \qquad dC_A/C_A = -kt$$
$$\ln (C_{Ao}/C_A) = kt$$

For the first set of conditions,

$$t = 1.0 \qquad C_{Ao} = 1.0 \qquad C_A = 0.785$$
$$\ln (1.0/0.785) = kt = 2.44$$
$$k = 2.44/1.0 = 2.44$$

For the second set of conditions,

$$t = 1.0 \qquad C_{Ao} = 2.0 \qquad C_A = 2\ (0.645)$$
$$C_{Ao}/C_A = 2/1.290 = 1.55$$
$$\ln (1.55) = 0.44 = kt$$
$$k = 0.44/1.0 = 0.44$$

Since k is not a constant for the two cases, the reaction is not first order. Assume zero order:

$$-dC_A/dt = k \qquad dC_A = -kdt$$
$$C_A = -kt + I$$

When $t = 0$, $C_A = C_{Ao}$ and $C_{Ao} = I$. Therefore,

$$C_A = -kt + C_{Ao} \text{ or, } C_{Ao} - C_A = kt$$

For the first set of conditions, $C_{Ao} = 1.0$; $C_A = 0.785$; $C_{Ao} - C_A = 0.215$ and

$$k = 0.215/1.0 = 0.215$$

For the second set of conditions, $C_{Ao} = 2.0$; $C_A = 2(0.645)$, or 1.290; $C_{Ao} - C_A = 0.710$ and

$$k = 0.710/1.0 = 0.710$$

Once again the value of k is not constant. The reaction is not zero order. Try second order:

$$-dC_A/dt = kC_A^2 \qquad -dC_A/C_A^2 = kt$$
$$1/C_A = kt + I$$

When $t = 0$, $1/C_{Ao} = I$ and therefore,

$$(1/C_A) - (1/C_{Ao}) = kt$$

For the first set of conditions,

$$t = 1.0 \qquad C_{Ao} = 1.0 \qquad C_A = 0.785$$
$$(1/C_A) - (1/C_{Ao}) = 0.275$$
$$k = 0.275/1.0 = 0.275$$

For the second set of conditions,

$$t = 1.0 \qquad C_{Ao} = 2.0 \qquad C_A = 2\ (0.645) = 1.290$$
$$(1/C_A) - (1/C_{Ao}) = 0.275$$
$$k = 0.275/1 = 0.275$$

This time k is a constant. Therefore the reaction is second order and

$$k = 0.275 \frac{\text{unit reactor volumes}}{\text{lb. mole-hr.}}$$

Now we can solve for the conversion at the third set of reaction conditions. At 6 atm., $C_{Ao} = 6.0$ and $C_A = 6\ (1 - x)$.

$$(1/C_A) - (1/C_{Ao}) = kt$$
$$1/(6 - 6x) = 0.275 + 1/6$$
$$x = 0.623 = 62.3\% \text{ converted}$$

Complex Reactions

Up to this point we have considered only the case where a single reaction proceeds in a clean-cut manner without any other complications such as side reactions or reverse reactions. A single irreversible reaction

$$A \longrightarrow R + S$$

or

$$A + B \longrightarrow R + S$$

is relatively easy to study but seldom occurs by itself.

There are usually other complicating reactions taking place at the same time. These make the study of the reaction more difficult; the combinations are termed complex reactions.

Almost all complex reactions may be classified as one of three general types or combinations thereof. They are:

Reversible reactions	$A \rightleftarrows R$
Consecutive reactions	$A \longrightarrow R \longrightarrow S$
Side reactions	$A \longrightarrow R$ $A \longrightarrow S$

Reversible Reactions

Reactions in which the products will react to form the reactants are reversible reactions. Such reactions

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UNUSUAL DESIGN for a chemical manufacturer. Note angle of ends of the 839 copper tubes. Fixed and floating heads are aluminum bronze. Photo from Camden Copper Works, Camden, N.J.

TWO COPPER mixers, used for coating and blending powder. Made by Camden Copper Works, including the rotating mechanism.

These two pictures show the versatility of Revere Copper. One, made for a chemical company, contains 839 copper tubes, and an unusual feature of the design is that the ends are cut at an angle. The fixed and floating heads are aluminum bronze. The other photograph shows two copper mixers, which rotate and are used for blending and coating powder. They are much like equipment employed in making coated candies.

These are examples of the special adaptability of copper. Both items were fabricated by the Camden Copper Works, Camden, N.J., which manufactures equipment to individual designs. Like Revere, it offers technical collaboration. It is an important Revere customer.

Remember, the copper shortage is over. Revere Copper is freely available now in plate, sheet, strip; rod and bar; tube and pipe; extruded shapes; forgings; lockseam tube and rolled mouldings. See the nearest Revere Sales Office. Write for free booklet, "Life Extension for Condenser Tubes."

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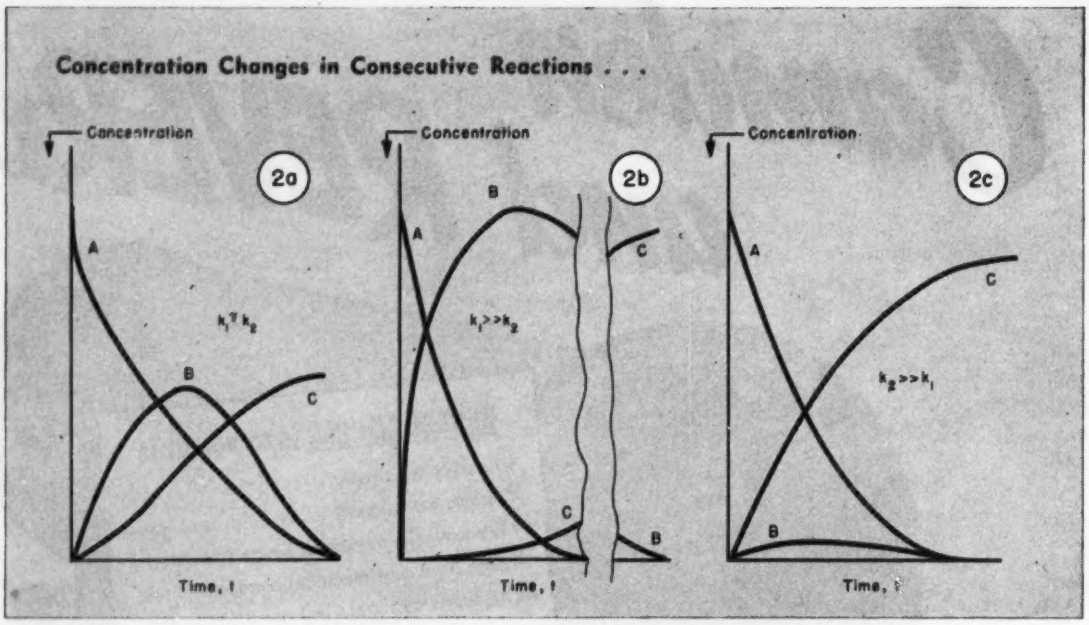

will come to equilibrium before the limiting reactant is used up. In the case of a simple order reversible reaction of the type

$$A + B \rightleftarrows R + S$$

the rate of the forward reaction is

$$r_f = kC_AC_B$$

and of the reverse reaction is

$$r' = k'C_RC_S$$

The net rate would be the difference of the two reaction rates.

$$r = r_f - r' = kC_AC_B - k'C_RC_S$$

The ratio of the forward and reverse rate constants is equal to the equilibrium constant. At equilibrium $r_f = r'$. Therefore, $kC_AC_B = k'C_RC_S$. Thus, k/k' equals C_RC_S/C_AC_B. By definition K (the equilibrium constant) equals C_RC_S/C_AC_B. Therefore,

$$K = k/k'$$

We can also write the net rate equation as:

$$r = k\,[(C_AC_B) - (C_RC_S/K)]$$

The numerical value of K corresponding to concentration must be used in this equation. Thus care must be exercised in selecting the proper standard state before calculating a value for K (see *Chem. Eng.*, June 1954, p. 246).

The net rate equation above is for the simple order reaction only. It has not been established, however, in the case of reactions that are not simple order that there is necessarily any relationship between the order of the forward and reverse reactions.

In investigating a reversible reaction it is usually recommended that the rate be studied by approaching equilibrium from both directions.

Consecutive Reactions

The simplest example of a consecutive reaction is one of the type

$$A \xrightarrow{k1} B \xrightarrow{k_2} C$$

This example is treated by Daniels ("Chemical Kinetics," Cornell Univ. Press, pp. 27-30, 1938). The concentrations of A, B, and C are given at any time, t, by the following equations:

$$C_A = e^{-(k1)(t)}$$

$$C_B = 2\,(1 - e^{-(k1)(t)}) - 2\,(1 - e^{-(k2)(t)})$$

$$C_C = 2\,(1 - e^{-(k1)(t)}) - (1 - e^{-(k2)(t)})$$

Even for this simple case the integral conversions are quite complicated. Typical plots of the concentrations of A, B, and C vs. time are shown in Fig. 2.

Fig. 2a is the case where k_1 and k_2 are of the same order of magnitude. In Fig. 2b, k_1 is very much greater than k_2; in Fig. 2c, k_2 is much greater than k_1.

Side Reactions

Competing reactions which take place at the same time are called side reactions. A simple example would be:

$$A \xrightarrow{k1} B$$

$$A \xrightarrow{k_2} C$$

If each of these reactions were simple first order, the rate equations would be:

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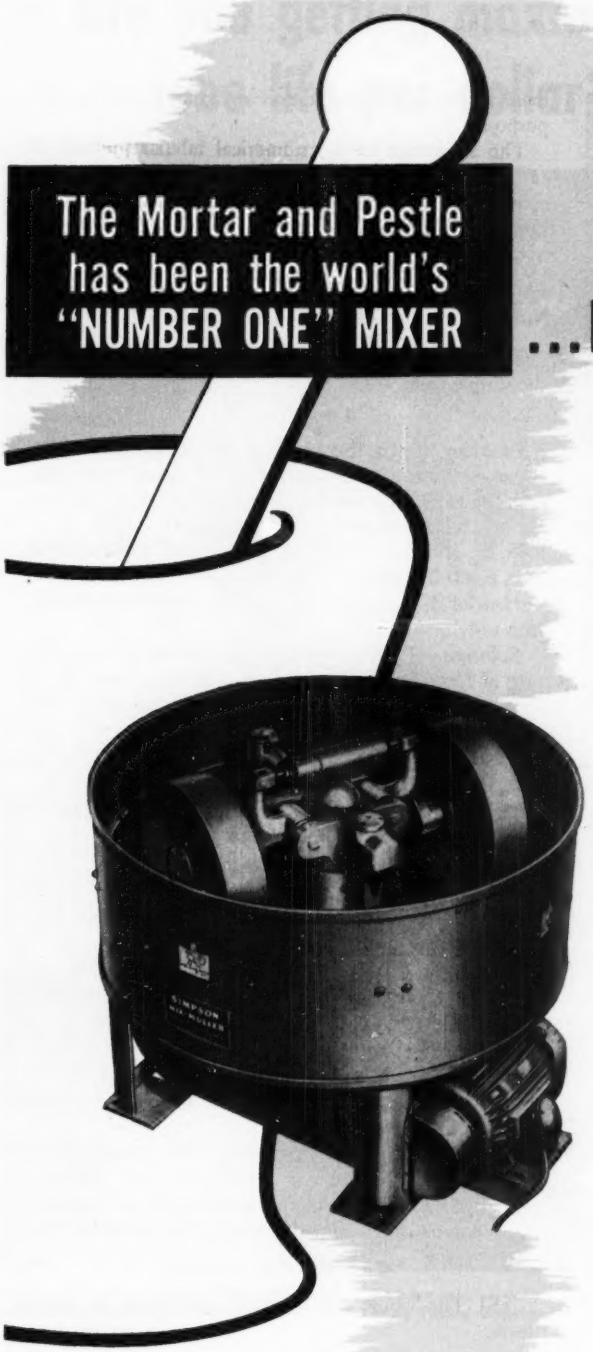

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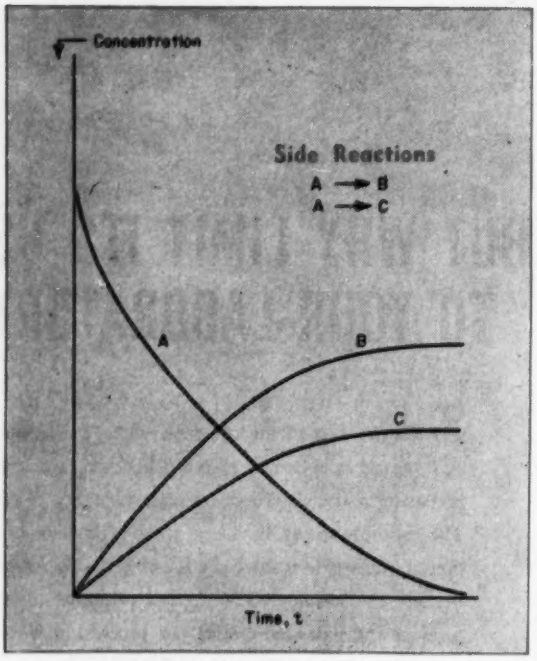

Fig. 3—Concentration changes in competing reactions.

$$-dC_A/dt = (k1 + k_2)\, C_A$$
$$dC_B/dt = k_1 C_A$$
$$dC_C/dt = k_2 C_A$$

The integrated forms of the equation for the concentration of component A would be similar to the equation for simple first order reactions.

$$\ln (C_{Ao}/C_A) = (k1 + k_2)\, t$$

The equations for C_B and C_C would not be simple. A typical plot of the concentrations vs. time is shown in Fig. 3.

Combinations of Complex Types

Most industrial reactions are combinations of these complex types. Consecutive reactions, side reactions, and parallel reactions are usually all going on simultaneously in a typical industrial reactor. The combination shown below is probably more representative of actual conditions in an industrial reactor.

$$A \rightleftarrows B \longrightarrow C$$
$$\Updownarrow$$
$$D \rightleftarrows E$$

Usually only one of the products formed is the desired one and the others appear as impurities. For such a complex combination of reaction as this the use of integral conversion equations is not feasible. They are too complex.

It is possible to calculate the concentration of each constituent as a function of time providing the rate constants for the indicated reactions are known. Numerical methods of integration are usually used for this purpose.

The advantage of the numerical tabular method: it can be used when combinations of reactions are too complex to be handled by analytical methods. The best way to explain the method of numerical analysis is to work out an example.

Numerical Analysis of Complex Reactions

To illustrate the tabular method, let's first consider the simple case.

$$A \longrightarrow B \longrightarrow C$$

Problem 1—In the unimolecular consecutive reactions above, the rate constant for A going to B is k_1 and the rate constant for B going to C is k_2. When the reactions are carried out at constant volume, $k_1 = 0.35$/hr. and $k_2 = 0.13$/hr. The initial concentration of A is 4.0 lb.-moles/cu. ft. Show a plot of the concentrations of A, B and C vs. time using numerical integration only.

Solution—There are three rates involved, r_1 is the rate of formation of component A, r_2 is the rate of formation of B and r_3 is the rate of formation of C. We can write these rate equations:

$$r_1 = -dC_A/dt = k_1 C_A$$
$$r_2 = dC_B/dt = k_1 C_A - k_2 C_B$$
$$r_3 = dC_C/dt = k_2 C_B$$
$$C_A = -k_1 C_A \Delta t = -r_1 \Delta t$$
$$C_B = k_1 C_A \Delta t - k_2 C_B \Delta t$$
$$C_B = (r_1 - r_3)\, \Delta t = r_2 \Delta t$$
$$C_C = k_2 C_B = r_3 \Delta t$$

The procedure for the numerical integration method is:

(1) Assume an increment of time.

(2) Assume average concentrations during that increment and calculate r_1, r_2 and r_3 for the average concentrations.

(3) From r_1, r_2 and r_3 calculate the change in concentration during the increment, ΔC_A, ΔC_B and ΔC_C.

(4) Using the calculated increments of concentration, correct the assumed average concentrations thus,

$$C_{A1} = C_{Ao} + (\Delta C_A/2), \text{ etc.}$$

(5) The whole calculation is best done in tabular form.

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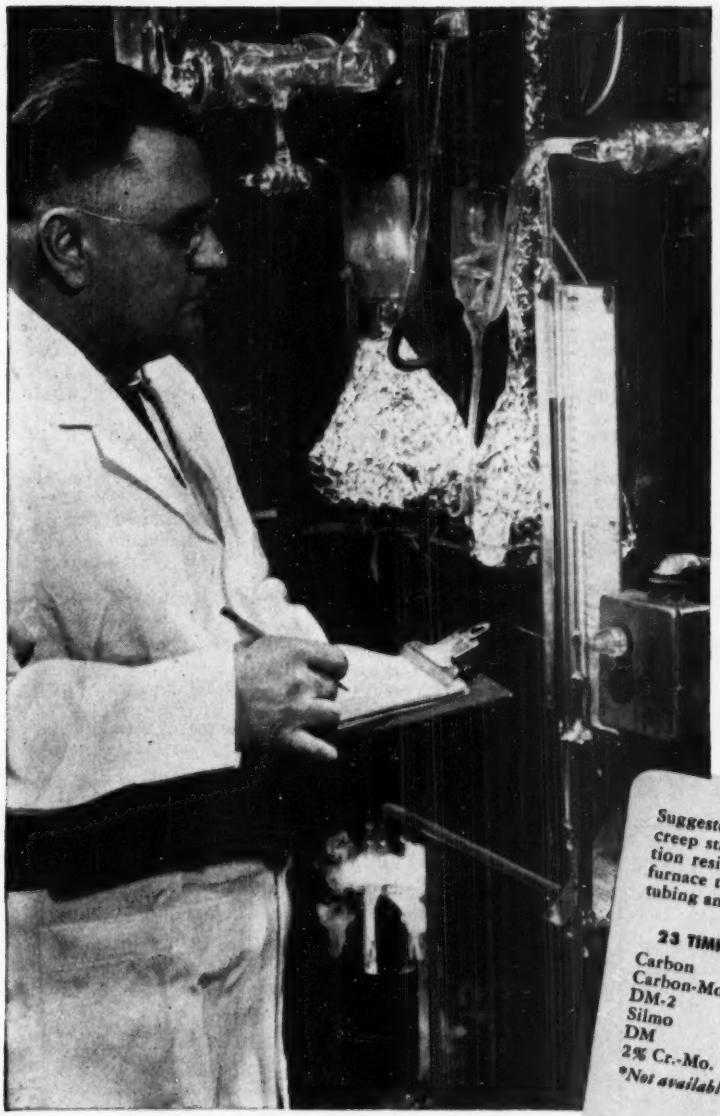

Vacuum fusion apparatus used to determine gases in steel. It's just one of the many phases of research on high temperature steel carried on by the Timken Company.

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This month the Timken Company reports on:

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23 TIMKEN STEELS FOR HIGH TEMPERATURE SERVICE

Carbon	Sicromo 2	Sicromo 5S	16-13-3
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Silmo	Sicromo 3	Sicromo 9M	25-15*
DM	4-6% Cr.-Mo.	18-8 Stainless	16-25-6*
2% Cr.-Mo.	4-6% Cr.-Mo.-Ti.	18-8 Cb	

*Not available as seamless tubing at the present time.

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Numerical Analysis Solution to a Complex Reaction Problem

t_1	Δt	t_2	C_A (Assumed Values)	C_B (Assumed Values)	C_C (Assumed Values)	r_1	r_2	r_3	ΔC_A	ΔC_B	ΔC_C	C_A (At End of Increment)	C_B (At End of Increment)	C_C (At End of Increment)
						k_1C_A	$r_1 - r_2$	k_3C_B	$-r_1\Delta t$	$r_2\Delta t$	$r_3\Delta t$	$C + \Delta C$	$C + \Delta C$	$C + \Delta$
		0	4.000	0	0							4.000	0	0
0	0.1	0.1	4.000	0	0	1.400	1.400	0	−0.1400	0.1400	0			
			3.930	0.07	0	1.380	1.371	0.0091	−0.138	0.1371	0.0009			
			3.936	0.068	0.00045	1.380	1.372	0.0082	−0.138	0.1372	0.00082	3.862	0.137	0.00082
0.1	0.1	0.2	3.867	0.137	0.00090	1.355	1.337	0.0178	−0.1355	0.1337	0.00178			
			3.868	0.135	0.00134	1.355	1.337	0.0178	−0.1355	0.1337	0.00178	3.726	0.271	0.0026
0.2	0.2	0.4	3.732	0.269	0.00312	1.305	1.270	0.035	−0.261	0.254	0.0070			
			3.737	0.262	0.0048	1.310	1.276	0.034	−0.262	0.254	0.0068	3.464	0.525	0.0094
0.4	0.2	0.6	3.333	0.655	0.0162	1.168	1.081	0.0865	−0.234	0.216	0.0173			
			3.347	0.633	0.0181	1.175	1.093	0.0820	−0.235	0.219	0.0164	3.229	0.744	0.0258
0.6	0.2	0.8	3.112	0.854	0.0422	1.090	0.879	0.111	−0.218	0.1758	0.0222			
			3.120	0.832	0.0369	1.091	0.983	0.108	−0.218	0.197	0.0216	3.011	0.941	0.0474
0.8	0.2	1.00	2.902	1.041	0.079	1.015	0.880	0.135	−0.203	0.176	0.0270			
			2.909	1.029	0.061	1.018	0.884	0.134	−0.204	0.177	0.0268	2.807	1.118	0.0742
1.00	0.2	1.20	2.705	1.206	0.0876	0.945	0.788	0.157	−0.189	0.158	0.0314			
			2.712	1.197	0.0899	0.949	0.793	0.156	−0.190	0.159	0.0312	2.617	1.277	0.1054
1.20	0.2	1.40	2.527	1.357	0.1254	0.885	0.708	0.177	−0.177	0.1416	0.0354			
			2.528	1.348	0.1231	0.885	0.710	0.175	−0.177	0.142	0.0350	2.440	1.419	0.1404
1.40	0.4	1.80	2.280	1.549	0.1804	0.796	0.594	0.202	−0.319	0.238	0.0808			
			2.280	1.539	0.1808	0.796	0.596	0.200	−0.319	0.238	0.0800	2.121	1.657	0.2204
1.80	0.4	2.20	1.980	1.790	0.280	0.693	0.460	0.233	−0.277	0.184	0.0930			
			1.983	1.749	0.267	0.694	0.466	0.228	−0.278	0.186	0.091	1.843	1.843	0.3114
2.20	0.4	2.60	1.740	1.920	0.365	0.609	0.359	0.250	−0.243	0.1435	0.100			
			1.721	1.915	0.361	0.602	0.358	0.249	−0.240	0.1415	0.100	1.603	1.985	0.411
2.60	0.4	3.00	1.510	2.040	0.490	0.528	0.263	0.265	−0.211	0.1052	0.1060			
			1.497	2.038	0.464	0.524	0.259	0.265	−0.210	0.1035	0.1060	1.393	2.089	0.517
3.00	0.6	3.60	1.300	2.140	0.650	0.455	0.177	0.278	−0.273	0.106	0.167			
			1.257	2.142	0.601	0.440	0.152	0.288	−0.264	0.091	0.173	1.129	2.180	0.690
3.60	0.6	4.20	1.020	2.200	0.840	0.357	0.071	0.286	−0.214	0.0426	0.172			
			1.022	2.393	0.776	0.357	0.046	0.311	−0.214	0.0275	0.186	0.915	2.208	0.876
4.20	0.6	4.80	0.800	2.230	1.000	0.280	−0.010	0.290	−0.1680	−0.006	0.174			
			0.831	2.202	0.963	0.291	+0.005	0.286	−0.175	+0.003	0.172	0.740	2.211	1.048
4.80	0.6	5.40	0.670	2.200	1.160	0.238	−0.048	0.286	−0.149	−0.0288	0.172			
			0.665	2.196	1.134	0.233	−0.053	0.286	−0.140	−0.0318	0.172	0.600	2.179	1.220

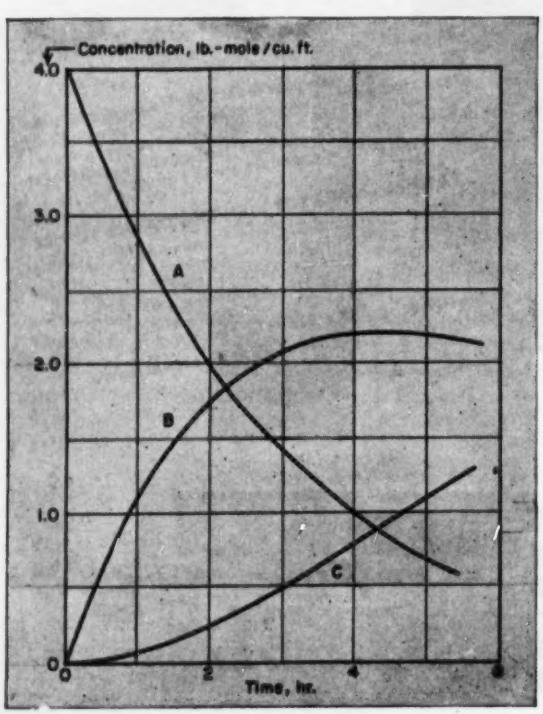
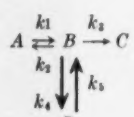


Fig. 4—Concentrations at end of increments

It is also helpful in making assumptions if you continue to plot the points as they are calculated.

The table above gives the results of the numerical calculation and Fig. 4 is a plot of the results.

Problem 2—Use the same numerical method and plot the concentration of each compound vs. time in the following system.



The initial concentration of A is 4.0 lb. moles/cu. ft.; $k_1 = 0.35$/hr.; $k_2 = 0.10$/hr.; $k_3 = 0.50$/hr.; $k_4 = 0.20$/hr. and $k_5 = 0.02$/hr.

Solution—The solution of this problem is left to the reader.

NEXT MONTH

Kinetics of Homogeneous Reactions—(III) will include the calculation of reactor size, for complex reactions and flow reactions, and a discussion of the latest homogeneous reaction theories.

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Mr. T. Ellwood Webster, President
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Congratulations on your completion of the ammonia-urea plant you built for us at Omaha, Nebraska, well ahead of the time schedule and comfortably within our cost estimates. It was a big, complicated job, involving some of our new process developments never before incorporated in a commercial plant. Few craftsmen were available familiar with the type of construction required, which was new to the Omaha area. In spite of these and other difficulties, it was altogether a fine performance and your organization is entitled to commendation for it.

Best personal regards.

Sincerely yours,

Hugo Kiemer
President

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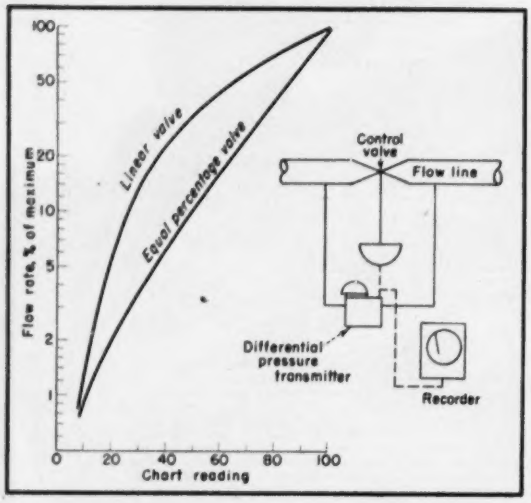
The Plant Notebook

Edited by Theodore R. Olive



Control Valve Serves as Flow Meter With Hundred-to-One Range

ALFRED H. MCKINNEY, *Engineering Service Div., Engineering Dept., E. I. du Pont de Nemours & Co., Wilmington, Del.*

★ **June Contest Prize Winner**

The assemblage of standard parts shown here will provide flow measurement over a range of at least 100 to 1. By comparison, the usual orifice plate gives a range of 4:1, or a rotameter a range of 10:1. This wide range is gained, of course, at a sacrifice of accuracy and sensitivity. However, the method does give a uniform rate of change of about 5% change in flow per percent change of chart reading. Since the scale is substantially logarithmic, the relative accuracy compared to the actual flow is essentially constant throughout the chart reading. This is in marked contrast to either a linear chart or a square root chart.

As the diagram shows, the flow passes through a control valve which serves as a variable orifice. A standard differential pressure measuring instrument is connected across the control valve and its pneumatic output is connected directly to the control valve and also connected in parallel to the flow recorder. Thus, as the differential pressure changes, the valve moves in unison. At no flow the control valve will be closed. As the flow starts it creates a small differential pressure and the valve opens to a certain extent. As the flow increases the differential pressure increases and the valve opens farther. The actual flow, therefore, is measured as the product of the area of the valve at a given position, times the square root of the differential pressure across the valve.

Calculated Calibration Curves for Variable-Orifice Meter.

	Linear Valve		Eq. Percent. Valve	
Pressure Drop, %	Valve Opening,* C_v, %	Calculated Flow, %	Valve Opening,* C_v, %	Calculated Flow, %
0	0	0.0	2	0.0
10	4	1.3	3	1.0
20	13	5.8	4.5	2.0
30	26	14	6.5	3.6
40	38	24	10	6.3
50	50	35	14	9.9
60	61	47	21	16
70	71	60	31	26
80	81	72	46	41
90	90	85	68	65
100	100	100	100	100

* Data from Hammel-Dahl Co. Eng. Data Bull. 200, p. 4 (1948). Note calculated flow equals $C_v\sqrt{\Delta p}$.

The accompanying table gives the arithmetic for the calculations of the expected flow rates and corresponding chart readings (as plotted on the chart). Obviously, the flow characteristics depend exactly on the valve characteristics. For the purposes of the table the valve characteristics were taken from the Hammel-Dahl Co.'s catalog, showing the relative flow rates for different percentages of valve travel for both a linear valve and an equal percentage valve. Presumably, valves from any other supplier would have substantially the same characteristics. For highest accuracy it would, of course, be appropriate to put a positioner on the valve so that an exact valve opening could be produced to correspond with any pressure drop.

★ **July Contest Prize Winner.**

"For Quicker Results Make Your Own Steam-Heated Drum Melter."

A prize of $50 in cash will be awarded to Paul Vandeven, pilot plant engineer, Monsanto Chemical Co., St Louis 4, Mo. Mr. Vandeven's simple and useful melter will appear in the October Plant Notebook.

$50 PRIZE FOR A GOOD IDEA—Until further notice the Editors of *Chemical Engineering* will award $50 cash each month to the author of the best short article received that month and accepted for publication in the Plant Notebook. Each month's winner will be announced the second following month and published the third following month.

$100 ANNUAL PRIZE—At the end of each year the monthly winners will be rejudged to determine the year's best Plant Notebook article, which will then be awarded an additional $100 prize.

HOW TO ENTER CONTEST—Any reader of *Chemical Engineering*, other than a McGraw-Hill employee, may submit as many entries for this contest as he wishes. Acceptable material must be previously unpublished and should be short, preferably not over 500 words, but illustrated if possible. Acceptable but non-winning articles will be published at regular space rates ($10 minimum).

Articles may deal with plant or production "kinks," or novel means of presenting useful data, which will interest chemical engineers. Address Plant Notebook Editor, *Chemical Engineering*, 330 West 42nd St., New York 36, N. Y.

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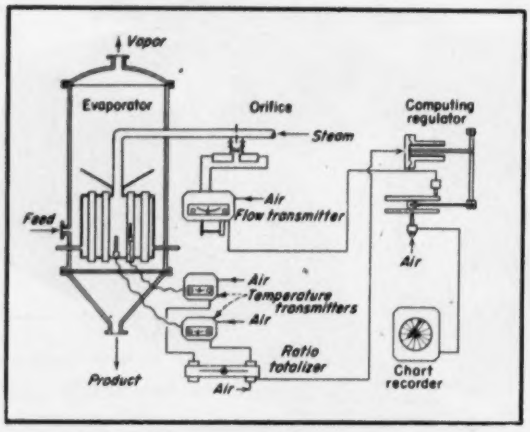
This set-up was devised initially to prevent back-flow, rather than for flow measurement. Obviously, as the pressure reverses, the valve will close and remain closed. It thus constitutes a positive check valve. When the assembly was put together in this combination its wide-range flow characteristics became apparent. It was then that calculations showed the actual flow characteristics of the system.



Instrument Set-Up Gives Continuous Record of Heat Transfer Rate

LEONARD STEBER, *E. R. Squibb, Inc., Div., Mathieson Chemical Corp., New Brunswick, N. J.*

Several methods have been described in the literature for finding the optimum economic operating time between cleanings of evaporators. When a true scale is formed the value of the heat transfer coefficient can be plotted as the inverse of the square of the coefficient, against time, using linear coordinates. This gives a straight line. The operating cycle can then be evaluated from the coefficient plot so as best to fit into production schedules and operating rate requirements.

In many evaporator installations, however, there is an unpredictable rate of change of the heat transfer coefficient with time. In such a case the value of the coefficient is commonly determined at any given time by measuring the variables in the equation $Q = UA\Delta T$.

A refinement of the method uses instruments to make the necessary measurements continuously, and convert them into an actual value of the overall heat transfer coefficient in the evaporator. This can be accomplished only if the liquid level in the body or tubes can be held constant, since the method assumes a constant heat transfer area in the above equation. The method is as follows:

1. The flow rate of steam to the tube bundle or calandria basket is recorded on a conventional orifice-type flow meter and transmitter; if appreciable steam pressure variation occurs, a record of the pressure vs. time should be maintained to correct the value of the heat transferred at any time as given by $Q = UA\Delta T$.

2. The temperature of steam in the tube bundle or basket, and the temperature of the boiling liquid at the mid-point of the liquid level, are transmitted to a ratio totalizer arranged to measure the difference between two input signal pressures.

3. Air output from the transmitter connected to the flow measuring device, and the air signal pressure from the ratio totalizer, are combined in a computing regulator to give an output air signal that is a measurement of the quotient of heat input divided by the temperature difference.

4. Output air from the computing regulator is transmitted to a recording chart instrument for plotting the values of $Q/\Delta T$ vs. time.

The overall heat transfer coefficient at any time is the value of $Q/\Delta T$ divided by the heat transfer area. The accuracy and consistency of this method depends on maintaining a constant value of the area of the tubes covered by the liquid. Changes in liquid level will result in changes in the average temperature drop and effective heat transfer area and result in indeterminate values of heat transfer coefficients.

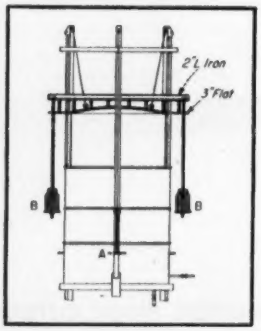
Determining apparent heat transfer coefficients can be accomplished by installing the thermowells of a temperature recorder in the vapor space above the liquid level, and in the steam chest, The corrected heat transfer coefficient at any time can then be determined by subtracting the average boiling point rise (based on a fixed liquid level) from the temperature drop given by the chart recorder; and dividing the product of that value and the area into the recorded heat transfer rate (Btu./hr.) at any time given by the flow rate of steam.

One advantage of this method compared with visual observation of factors involved in heat transfer coefficients is that rapid development of fouling can be measured on a second-to-second basis.

Weighting Arrangement Adds Pressure To Laboratory Gas Holders

H. K. JOSHI AND M. U. PAI, *Chemical Engineering Div., National Chemical Laboratory of India, Poona 8, India.*

Small gas holders of about 50-100 cu. ft. capacity are often employed for storing gases for use in further operations. The gas is collected as usual under slight suction obtained by the use of counterweights.



Sometimes the stored gas must be retrieved for short periods under pressures greater than those obtainable with the help

DARCO Digest

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Application: decolorizing, deodorizing, or general purification?

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For a brief description of evaluation methods, write for a copy of the booklet, "8 Ways to Get The Most From Darco."

Darco activated carbon is made from materials of vegetable origin

Activated carbon can be made from practically any material that has a high carbonaceous content.

Darco activated carbon, however, is entirely vegetable in origin. Much of it is made from Texas lignite, which the Germans know as brown coal. Some grades are derived from wood sawdust. Darco G-60, the premium-purity grade, is manufactured from high quality wood charcoal.

The activation process used for making Darco consists of heating to high temperature under mild oxidizing conditions. Following this, all extractable contaminants are thoroughly removed by successive washing in acids and water.

DARCO'S low retention saves valuable product

Any activated carbon used for purification will hold back some of the liquor being processed. The amount of liquor that stays in the filter cake can represent a sizeable economic loss. When dealing with pharmaceuticals, edible oils and chemicals which have a high cost per pound, it pays to choose a carbon that provides the minimum retention loss.

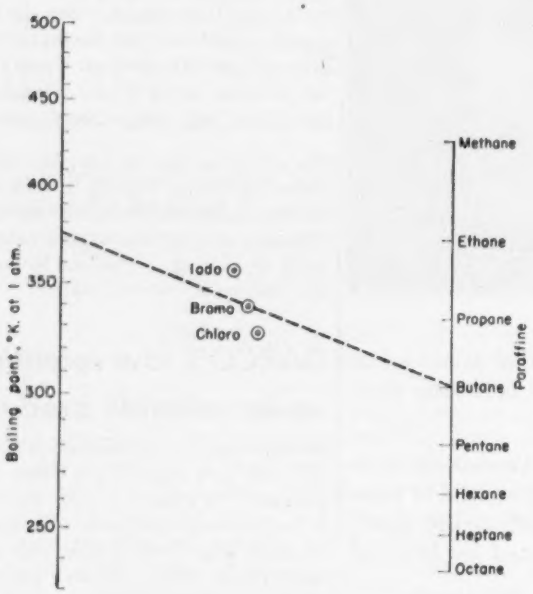
Darco G-60 is recommended for applications where retention loss can prove costly. Because it often holds back only half as much product in the cake as other carbons, Darco G-60 frequently pays for itself in greater yield at the filter press.

If you're purifying valuable product, we suggest that you send for a sample of Darco G-60. Test it thoroughly in your own laboratory. Compare its retention against any other carbon. You'll probably find that this premium grade will prove the most economical for your application.

of the weight of the holder drum alone. Storage of water on top of the drum to increase its weight and pressure requires considerable modification of the drum. Use of a blower may not always be possible or convenient.

We have successfully used a simple device that can be easily fabricated. As the sketch shows, it consists of a cross beam of angle iron joined to a bent flat plate resting on top of the drum. Two pans are suspended at the ends of the beam. Care should be taken in installing it to avoid undue local stresses on the top of the drum.

To obtain the desired outlet pressure after the gas holder is filled under suction, we move weights from counterweight pans *A* and add them equally to pans *B*. Additional weights can also be added to *B* to obtain the desired pressure. The whole device is simple to install and dismantle and does not need special equipment or important modifications in the gas holder.



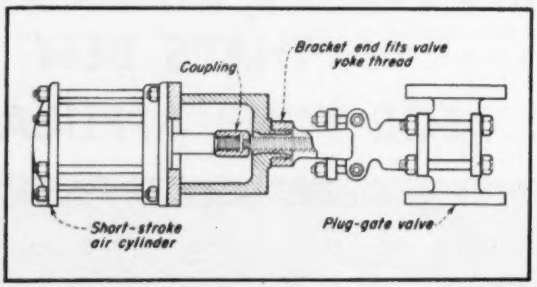
New Nomograph Finds Boiling Points Of Halogenated Paraffines

JOSEPH T. HOGAN, *Chemical Engineer, New Orleans, Louisiana.*

In a recent study Varshni (*J. Indian Chem. Soc.*, 30, 169, 1953) has found a simple relationship to exist between the boiling points of a normal paraffine and its monhalogen derivative, which can be represented by the formula $T^{\circ}_{a} - T^{\circ} = K$, where T and T_a are the boiling points (°K. at 1 atm.) of the paraffine and the corresponding monohalogen derivative, and K is a constant.

The results of this study lend themselves to simple nomographic representation and a line coordinate chart is shown above. As an example of its use, what is the boiling point of *n*-butyl bromide? A straight edge, connecting butane on the right scale with the point coordinate for the monobromide derivative, intersects the left scale at 375°K. Therefore, the boiling point is 375 − 273 = 102°C.

It should be noted that *n*-octyl iodide decomposes at its boiling point.



In an Emergency— Construct Your Own Control Valve

L. O. ALFORD AND C. E. DRYDEN, *Pilot Plant Div., Battelle Memorial Institute, Columbus, Ohio.*

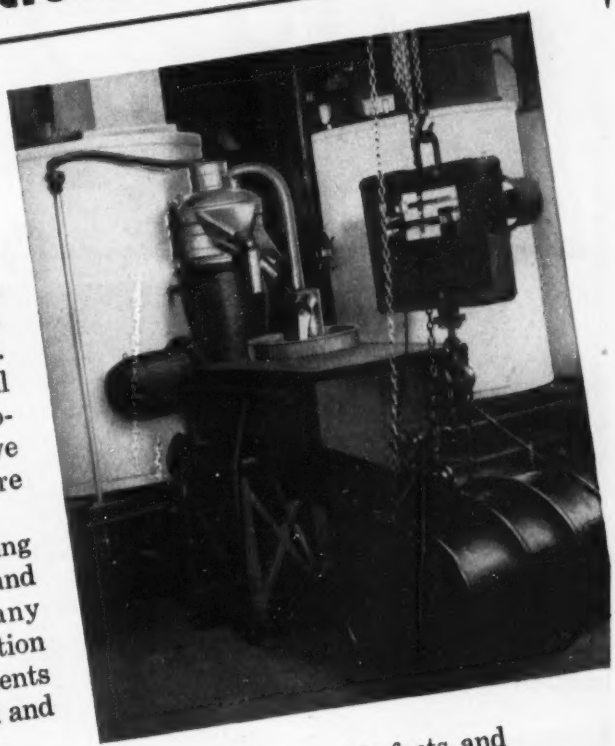
In cases where a diaphragm or solenoid valve for on-off control is immediately required and the delivery date for standard equipment is not suitable, a standard type hand valve can easily be converted to automatic control.

As one example, the accompanying drawing shows how an outside-screw-and-yoke type gate valve was coupled to a short-stroke air cylinder. The mechanical connection was accomplished by fabricating a bracket, one end of which was threaded to fit existing threads in the valve yoke, the other flanged for bolting to the air cylinder. A special coupling was also made to connect the cylinder rod and the valve stem. This coupling made use of the existing threads on both the rod and the stem.

Thus, only two new parts were required and the only alteration made to the valve was the removal of the hand wheel and the nut, in which the threaded section of the stem normally operates. This may be done with any type of rising-stem valve, provided suitable alterations are made in the bracket and valve body or yoke.

The size of the air cylinder required varies with the valve size and the available air pressure. It was found that 600 to 1,000 lb. force on the stem was required with the 1½-in. valve used in this case. A relay-operated pilot air valve or a small electric solenoid valve connected to a thermocouple-potentiometer type control instrument regulates the air supply to the driving cylinder.

DE LAVAL CENTRIFUGALS
Break Production Bottlenecks



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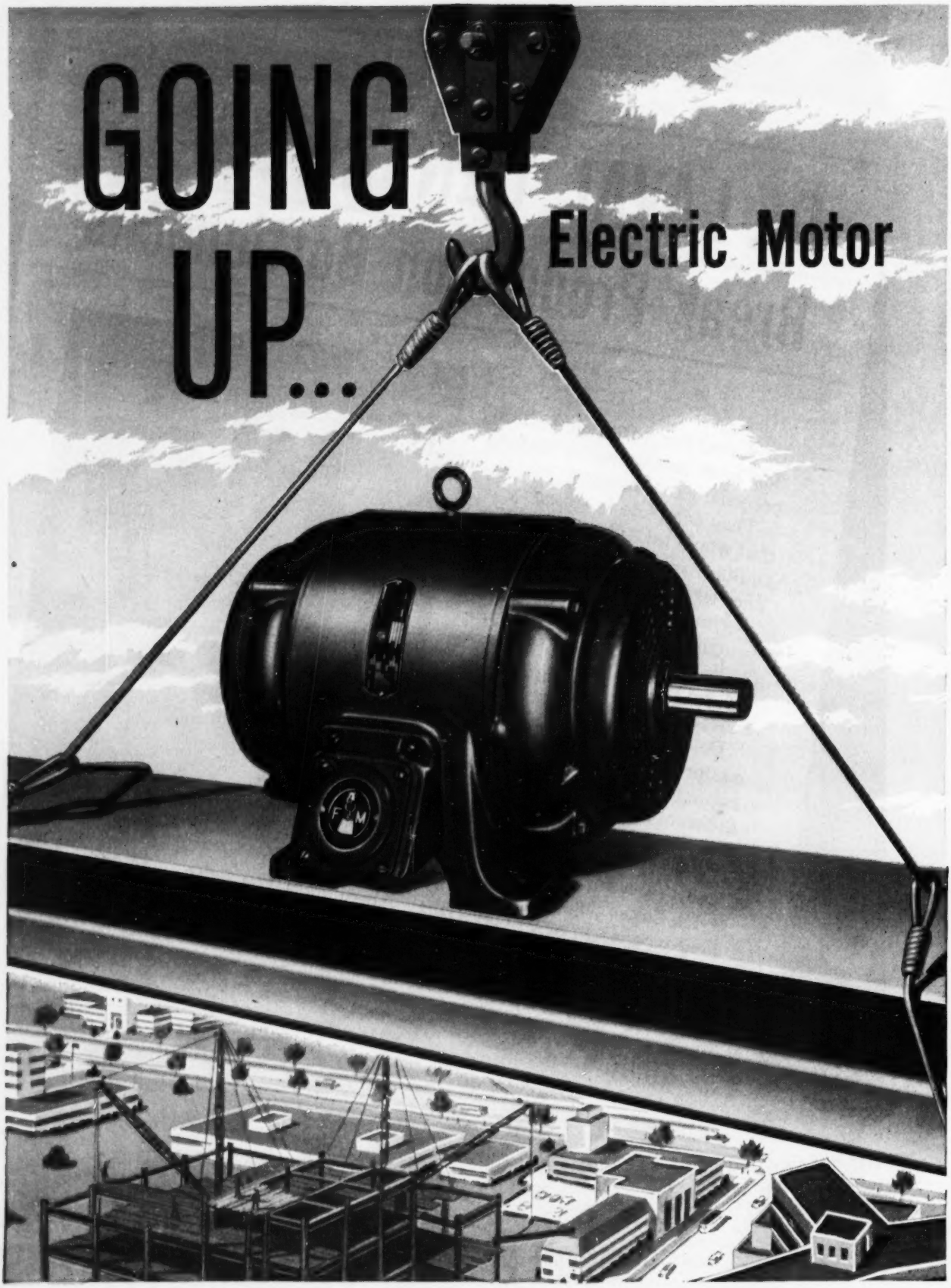
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More Performance in Less Space.

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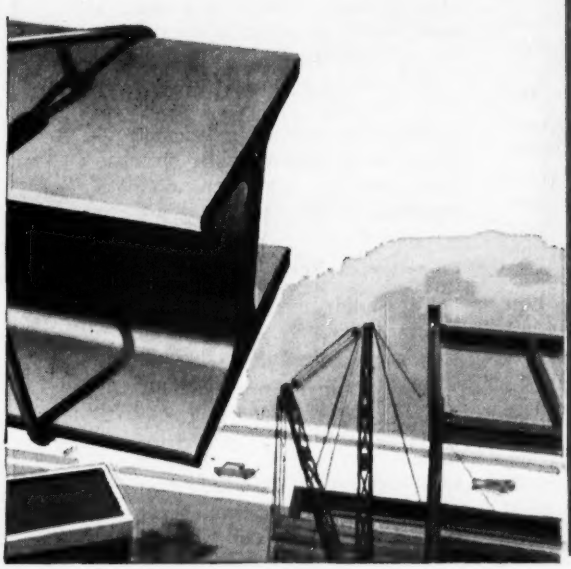

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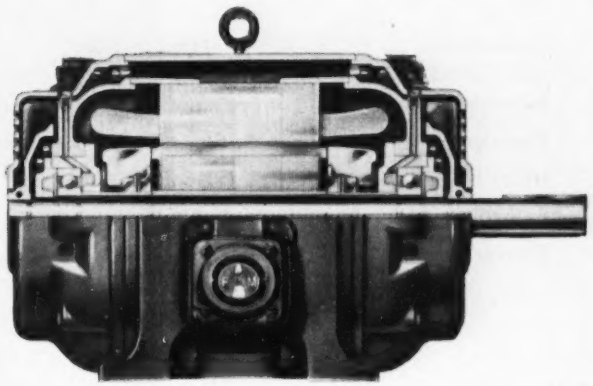
TOTALLY ENCLOSED FAN-COOLED MOTORS



TOTALLY ENCLOSED—Wherever adverse operating conditions are encountered, F-M totally enclosed construction effectively insures electrical parts and bearings against contamination by dirt, abrasive dusts, metal particles, corrosive gases and steam.

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COPPERSPUN ROTOR—Exclusive Fairbanks-Morse feature—an indestructible one-piece rotor—homogeneous, free from flaws for maximum strength and lifetime service.

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Trade Names	Manufacturer	Number of Crude Polymers Available
Butaprene	Firestone Tire and Rubber	4
Chemigum	Goodyear Tire and Rubber	4
Hycar	B. F. Goodrich Chemical	12
Paracril	United States Rubber	8
Polysar	Polymer Corp., Ltd. (Canada)	3

Nitrile Rubber for Oils and Solvents

More expensive and more difficult to fabricate than natural rubber, nitrile nevertheless has many important uses as solid forms and sheet linings.

JAMES P. McNAMEE

First article in this series (Aug. 1954, p. 234) dealt with natural rubber and type GR-S synthetic rubber. This second article will extend the presentation to include the special-purpose nitrile type synthetic rubbers.

Nitrile rubbers are so named because they are formed by combining acrylonitrile with butadiene. You will recall that the GR-S synthetic rubbers are made from styrene and butadiene. Substitution of acrylonitrile for styrene produces a synthetic rubber (or as it is more properly called, a synthetic elastomer) having excellent oil resistance and good resistance to aging and attack by chemicals.

Vulcanized items made from natural rubber and GR-S will swell and deteriorate rapidly in contact with various oils and solvents, such as lubricating oils and gasoline. Vulcanized nitrile elastomers may, however, be used for considerable periods in contact with these materials.

JAMES MCNAMEE *is a chemical engineer with the U. S. Rubber Co., Providence, R. I.*

Manufacture of Nitrile Rubber

Crude nitrile rubber is produced by copolymerizing a mixture of acrylonitrile and butadiene to which various modifying agents are added. The ratio of acrylonitrile to butadiene in the crude polymer has a great influence on its physical and chemical properties—particularly swelling in oil and low temperature flexibility.

Crude nitrile rubbers are now made by five companies each producing a series of polymers with varying acrylonitrile content. The table lists the manufacturers' names, as well as the trade names, of the crude polymers.

These materials may be purchased by any rubber manufacturer for fabrication into industrial rubber items such as molded gaskets, diaphragms, O-rings, tubing, hose and roll coverings. They may also be fabricated into sheet linings for tanks and pipe.

Products made from crude polymers of the same acrylonitrile content produced by different manufacturers will have, approximately the same physical and chemical properties.

Processing of Nitrile Compounds

Crude nitrile polymers are compounded, processed and vulcanized in much the same manner as natural rubber using the same factory equipment.

They are more expensive to handle than natural rubber, however, because of the inherent dryness of the crude polymers. Even the use of large quantities of softeners does not completely equal the processability of natural rubber.

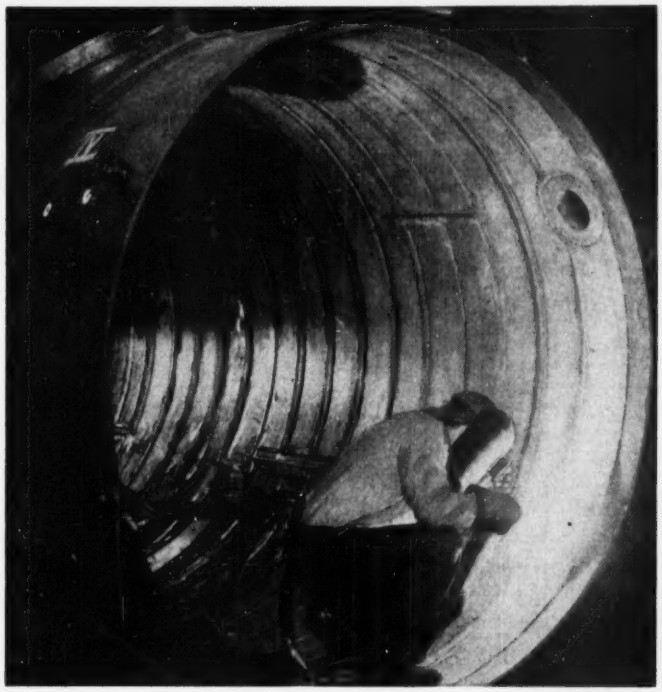
Nitrile polymers also differ from natural rubber in one other important respect. Carbon blacks must be used as fillers to obtain good physical properties in the vulcanized elastomers.

Depending on the end product desired, nitrile rubbers may be vulcanized by molding in hydraulic presses or by heating under open steam pressure, hot water or atmospheric steam.

Properties of Nitrile Rubbers

Vulcanized nitrile elastomers having physical properties in the same range as natural rubber can be made by proper compounding. Since carbon black must be used to accomplish this, it is not possible to make products of a pure-gum type, such as can be made from natural rubber. Practical light-colored compounds can be made

Made to Last in Severe Corrosives

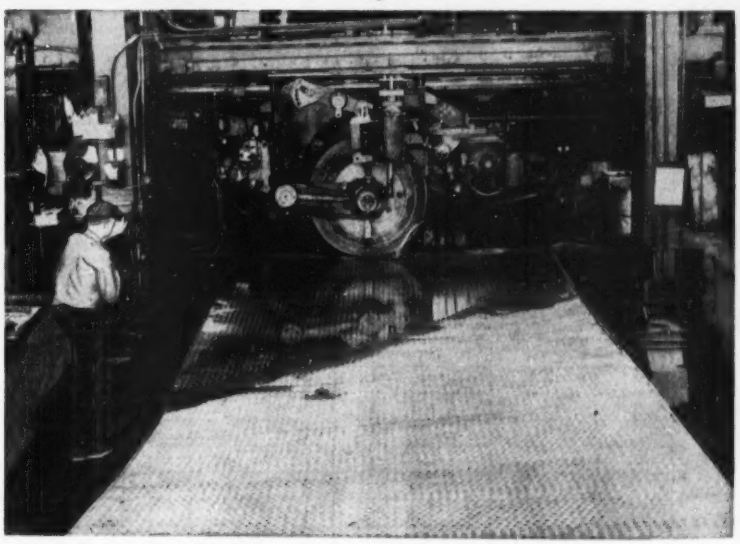


A TOWER OF RESISTANCE

Strips of HASTELLOY alloy C are being arc-welded to this 44-ft. long tower to give it added corrosion resistance. The entire inside surface of the vessel is covered with ⅛-in. thick sheet.

SEALING OUT CORROSION

This lining of HASTELLOY alloy F will resist acids and alkalies. It is attached to steel by the Smithlining* spotweld process, one of the many ways of attaching HASTELLOY alloys to steel. Use of lined-sheet is an economical means of handling severe corrosives.



HASTELLOY alloys can help solve your corrosion problems, too. For further information, contact the nearest Haynes Stellite Company office.

*"Smithlining" distinguishes an exclusive process of the A. O. Smith Corporation, Milwaukee, Wisconsin.

HASTELLOY *alloys*

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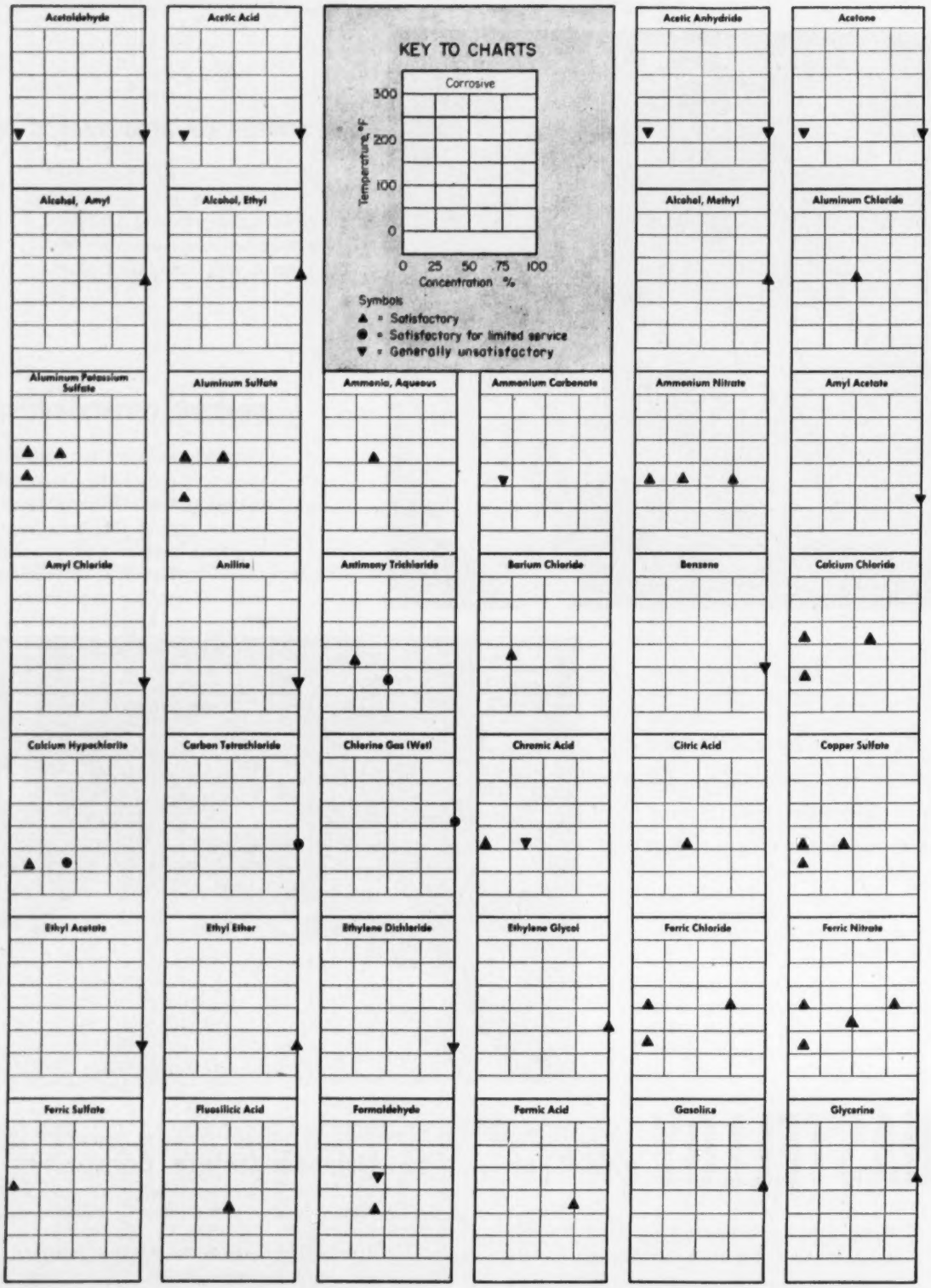
Corrosion Resistance of Nitrile Rubber



(Continued on page 234)

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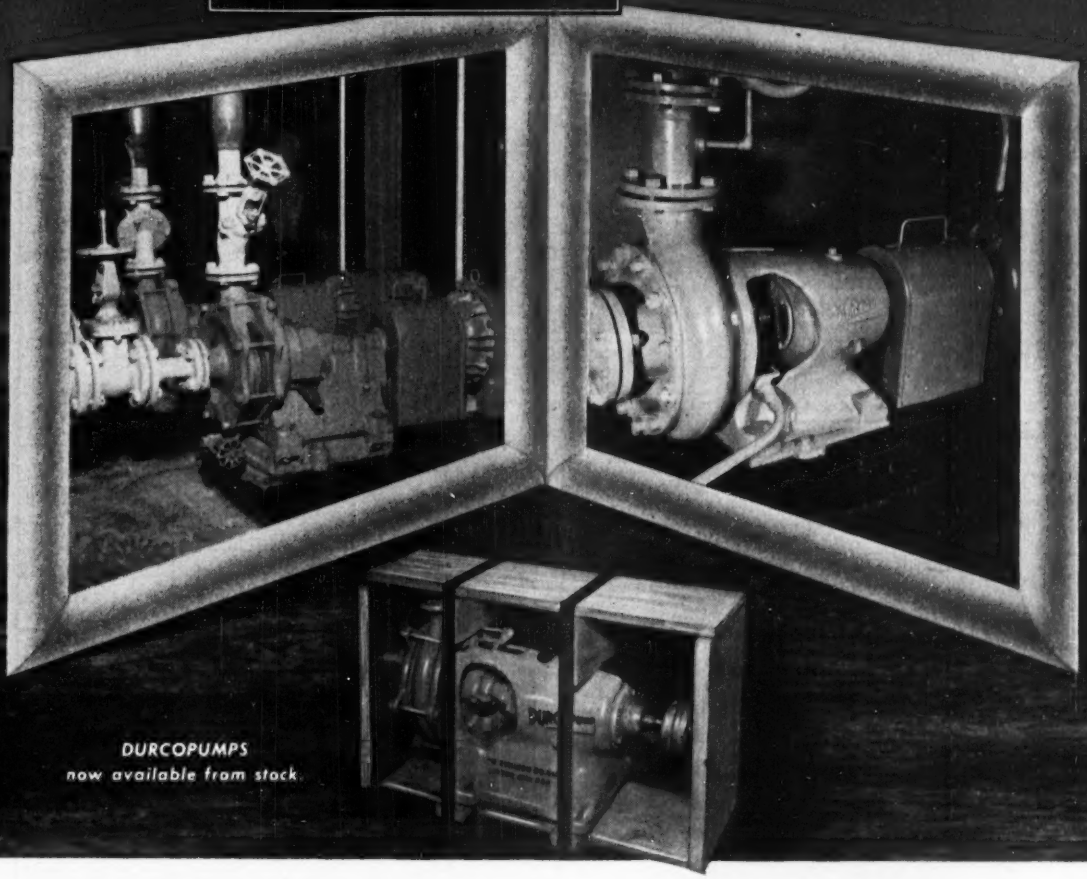

DURCOPUMPS
now available from stock.

Durco has served Hercules for many years. The model 30 pumps pictured at the left *(above)* were installed about 1939, and are still in daily operation. The Model 40 pumps at the right *(above)* have been in continuous service for about eight years. Recently during Hercules' expansion program at Parlin, Durcopumps were again specified.

Hercules is a leading producer of cellulose products, resins, terpene chemicals, rosin and rosin derivatives, chlorinated products, industrial explosives, and many other materials.

The Duriron Company has been serving the world's leading manufacturers for more than forty years with process equipment for tough chemical services. Many leading companies have standardized on Durco equipment for long trouble-free life when handling severe corrosives.

Durco Catalog 54 briefly describes Durco alloys and equipment, and lists detailed bulletins covering specific items.

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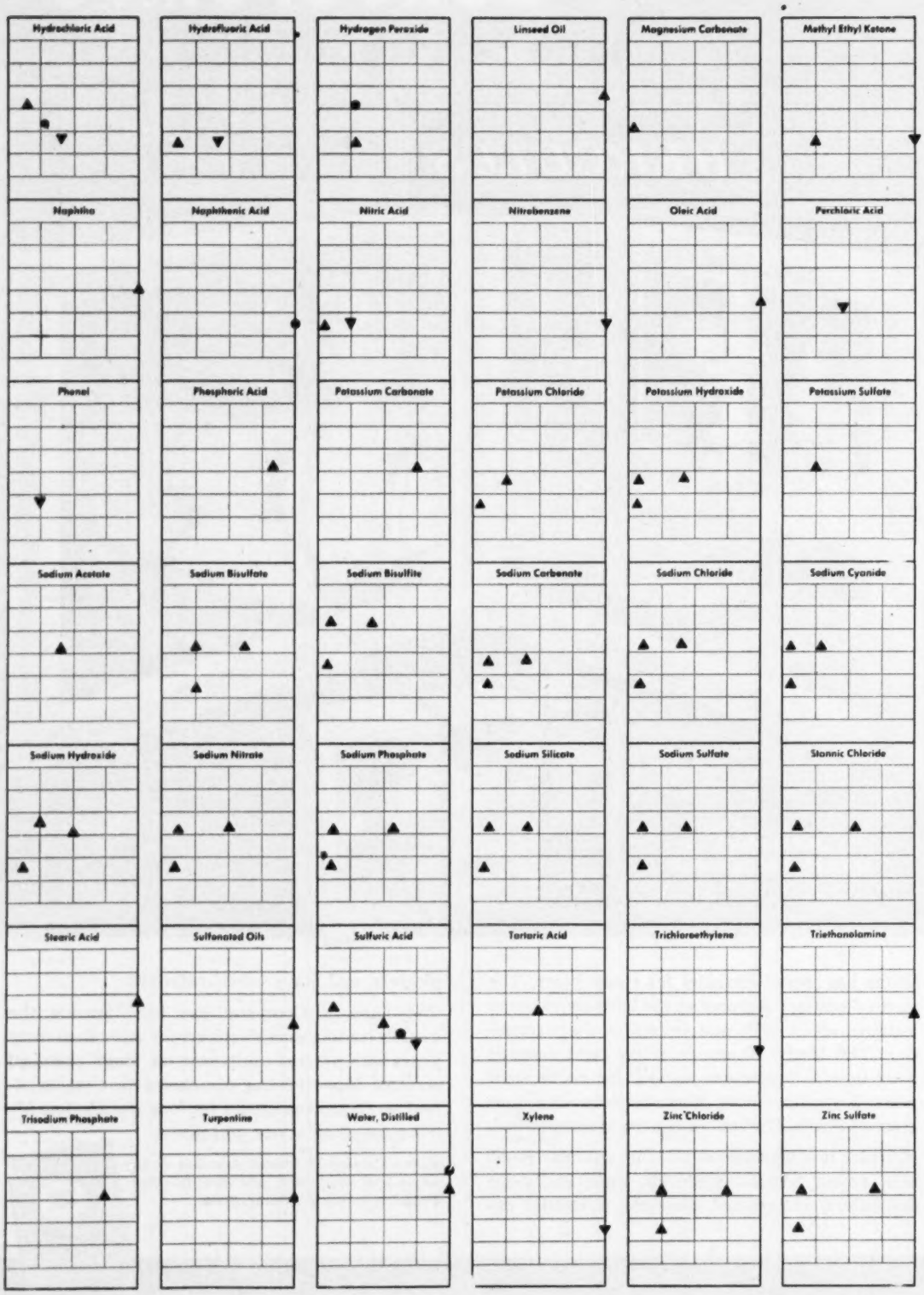
CORROSION RESISTING ALLOYS & EQUIPMENT

THE DURIRON COMPANY, INC. / DAYTON 1, OHIO

Corrosion Resistance of Nitrile Rubber



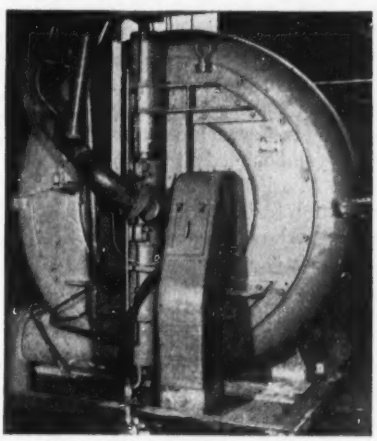
(CORROSION FORUM, continued on page 236)

the *Complete line* of Reineveld Centrifugals is now available through Heyl & Patterson

No matter how difficult your separating or drying problem may be . . . whether you require large or small capacity, very high or relatively low centrifugal force, perforated basket or solid bowl . . . you'll find the answer to your problem in the *complete* line of Reineveld Centrifugals.

The Reineveld Centriplane . . .

is a vertical perforated basket centrifugal designed for continuous operation. The standard models of the Centriplane have bowl diameters of 8", 16" or 25", the use of each size depending upon the material being processed and the tonnage required. The Reineveld Centriplane is especially advantageous on quick-draining materials such as ammonium sulphate, Glauber salt or wherever else CONTINUOUS operation is best applied.



The Reineveld Horizontal-Basket Centrifugal . . .

uses either a perforated basket or solid bowl. This is an automatic batch-type machine ranging in drum size from the 16" laboratory or pilot plant model to the 100" double-basket model. In addition to its use on quick-draining materials the Reineveld horizontal-basket Centrifugal gives outstanding performance on products that are difficult to de-water.

Compare the COMPLETE line of Reineveld Centrifugals on price, production, capacity, maintenance costs or on any other factor you choose. See for yourself why the Reineveld Centrifugal is your best buy.

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"SINCE 1887"

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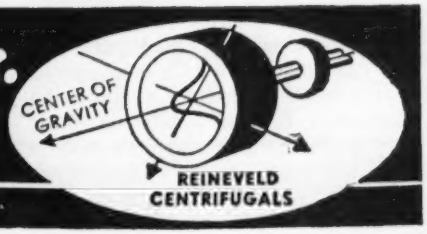

by using high loadings of clay or silicate fillers.

Physical and chemical properties of nitrile elastomers depend on the acrylonitrile content of the crude polymer from which they are made. As the percentage of acrylonitrile is increased, the swelling in various types of oil is reduced—but the low temperature flexibility is seriously impaired.

Reducing the acrylonitrile content of the polymer results in greater swelling in oils but considerably improves the low temperature flexibility. A compromise must be reached on this point depending on which property is more important in the final product.

Reason for this change in oil resistance is due to the incompatibility of the acrylonitrile component of the elastomer and pure hydrocarbons such as oils and aliphatic solvents. These oils and solvents will swell the butadiene part of the elastomer but not the acrylonitrile part. Increasing the acrylonitrile content of the polymer, therefore, directly decreases the oil swelling.

Vulcanized nitrile elastomers are more resistant to heat aging than natural rubber and may be exposed to higher operating temperatures.

Properly-compounded nitriles also have good abrasion resistance and compression set. They have permanent set values comparable to natural rubber.

Since nitrile elastomers are vulcanized with sulfur in the same manner as natural rubber, the hardness can be increased to ebonite by increasing the amount of sulfur combined in the elastomer. In the soft rubber range, hardness variations are best accomplished by changes in the filler loading.

Blends of nitrile rubbers and phenolic resins are being used in ever increasing quantities to produce many industrial products. Ratio of phenolic resin to nitrile rubber can be varied from low amounts (10 to 25% based on the nitrile) which have a reinforcing effect, to equal amounts of nitrile and resin. Equal amounts produce hardnesses in the ebonite range but without the brittleness of ebonites made from high sulfur. Blends of nitrile rubbers and polyvinyl chloride also produce very useful cured compounds.

Oil Resistance of Nitrile Elastomers

With respect to their swelling action on vulcanized nitrile compounds, oils and solvents may be grouped into three classes:

1. Those which do not swell the elastomers. Examples: aliphatic hydrocarbons such as gasoline, mineral spirits and kerosene; lubricating oil and grease; turpentine and linseed oil.

2. Materials having a limited swelling affect on nitriles. Elastomers may be exposed to these oils and solvents for extended periods unless the rubber item is one in which very critical dimensions must be maintained. Examples: aromatic aviation gasoline, sulfonated oils.

3. Solvents which definitely swell nitrile elastomers. Items made from nitrile elastomers cannot be used in continuous contact with these solvents. Examples: chlorinated solvents such as ethylene dichchloride and trichloroethylene, and aromatic hydrocarbons such as benzene, toluene and xylene.

These general statements on the oil resistance of nitriles refer to the highest acrylonitrile polymer of each manufacturer. Since the medium and low acrylonitrile polymers have less oil resistance, a Class A solvent may drop into Class B for the lower acrylonitrile polymers. In the same manner Class B solvents may drop into Class C.

Another important factor must be considered when discussing the oil resistance of nitrile rubbers. Relatively large amount of softeners, such as coal-tar derivatives and organic esters, are used to improve the processing properties of the unvulcanized compounds. Certain of these softeners considerably improve the low temperature flexibility of the vulcanized elastomers and are added for that purpose. Since these softeners are soluble in oils and solvents, exposure of the vulcanized nitrile elastomer to various solvents will result in extraction of the softeners.

Two reactions, then, take place at the same time when a vulcanized nitrile product comes in contact with a solvent. The elastomer is swollen to a greater or lesser extent depending on the factors already discussed and the softeners will be extracted to an extent depending primarily on the type of solvent, type of softener, and length of contact. If the solvent is one which does not swell the elastomer, extraction of softener will result in a loss in volume. In some cases swelling and extraction will take place simultaneously and result in no volume change.

Extraction of softener, even if it seems to keep the volume constant, is undesirable because it makes the elastomer harder and spoils its low temperature flexibility.

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For your information and convenience, here is a tabulation of the materials of construction which have been covered thus far in the current Corrosion Forum series:

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Worthite	Nov. 1953
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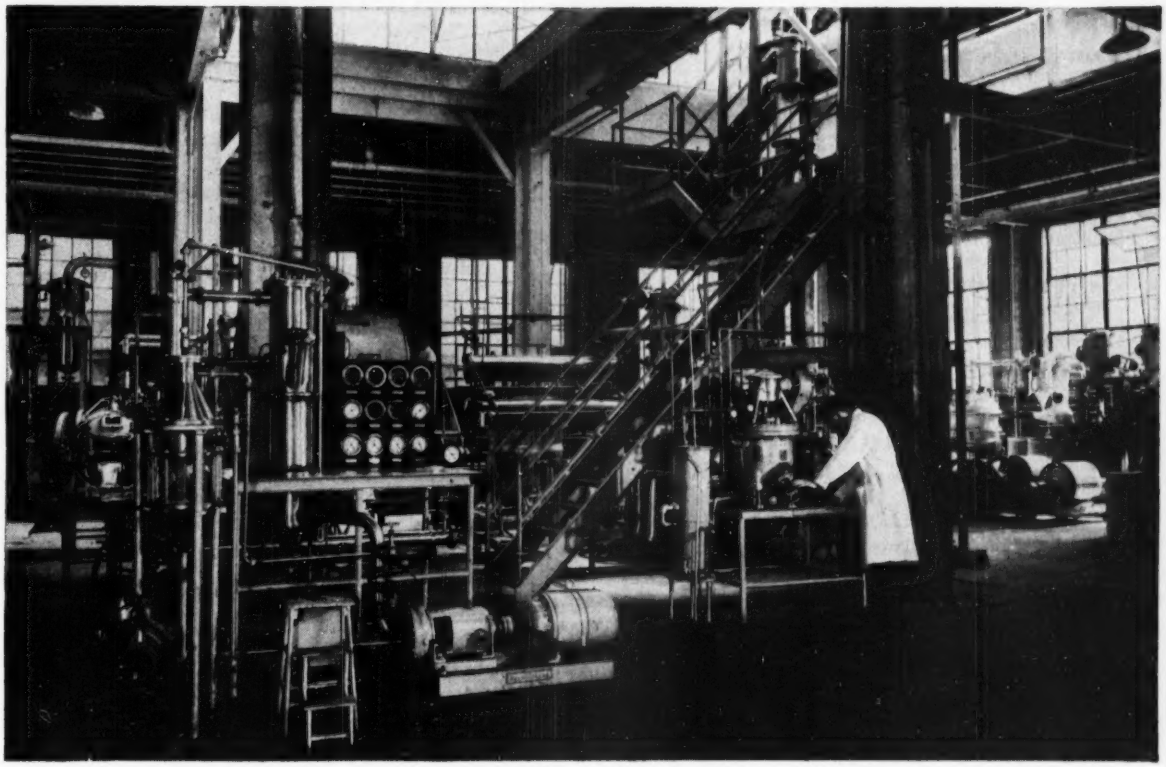
Reprints of most of the above are available at 50 c. each (Hastelloys and Stainless Steels, 75 c. each.) Address Reprint Dept., Chemical Engineering, 330 W. 42 St., New York 36, N. Y.



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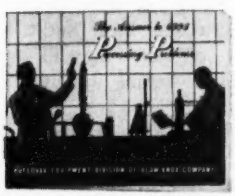

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The tests range from a few beakers of precious chemicals and antibiotics to tank cars of material requiring round-the-clock operation on a production scale. The data obtained from this pre-testing has resulted in the right answer to more than 7000 processing problems in the chemical, food, pharmaceutical and similar industries.

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An actual or simulated service trial is the only method of resolving these various factors for a particular application. It should be carried out if there is any doubt concerning suitability.

Chemical Industry Applications

The chemical industry is finding an ever-increasing number of uses for products made from nitrile rubbers. Since the nitriles are more expensive and more difficult to fabricate than natural rubber, their use is limited to service conditions which require exposure to oil and solvents. Chemical resistance of vulcanized nitriles follows the general pattern set by natural rubber.

Molded items used in oil field operations are made from nitrile compounds, generally of the high acrylonitrile type. These include oil well sleeves, pipe protectors, seals and packings of all kinds.

Molded gaskets for gasoline storage tanks and other units containing oils or solvents are successfully manufactured from nitriles.

Hose to handle gasoline and fuel oil is made either entirely of a nitrile compound or with an inner tube of nitrile and an outer covering of a less expensive material.

Conveyor belts are fabricated with an outside covering of a nitrile compound for transporting various oily materials.

Army and Navy specifications for oil and gasoline hose, items to be exposed to hot oil and coolants, and many others require the low oil swelling properties of nitrile compounds. In most cases, these specifications also contain a requirement on low temperature flexibility. Medium or low acrylonitrile elastomers with carefully chosen low temperature plasticizers are used to meet these specifications.

Quick-acting valves handling aviation gasoline on aircraft carriers are now made with a nitrile-covered plug. The resilient covering provides a vapor tight seal against leakage of gasoline fumes. These plugs may be covered with nitriles either by molding or by the hand application of unvulcanized calendered stock.

Sheet linings of nitrile compounds may be applied to any type of process or storage tank, pipe, valves and blowers. Units protected in this manner can be used in contact with acid and salt solutions containing aliphatic solvents or sulfonated oils.

Nitrile compounds of this type are applied in the unvulcanized form and then heated either in a steam pressure autoclave, in hot water or dry heat, to bring about the vulcanization process. These linings can be applied in the field to equipment already erected in place.

Industrial rolls covered with nitrile compounds are satisfactory for use in contact with solvent solutions used to coat paper, metal and textiles. These few examples will give an idea of the various ways in which nitrile compounds may be used in various industrial applications.

The accompanying graphs will serve as a guide in determining the suitability of this type of rubber for service conditions of particular interest to the reader.

These graphs are based on the resistance of practical nitrile compounds. Even more important than in the case of natural rubber, samples of the particular nitrile compound under consideration should receive a thorough evaluation test under actual or simulated service conditions before deciding to use the item in contact with a certain solution.

Towards Better Containers . . .

Users of chemicals have a big stake in research being done to improve the performance of steel shipping containers as it affects handling costs and product quality. Recently announced are results of work being done on phosphate treatments at Battelle Memorial Institute, Columbus, Ohio, for the Steel Shipping Container Institute, Inc.

This work has shown that the phosphate pre-treatments must still be considered mainly from their performance on container exteriors and in unlined containers.

It appears that the general use of phosphate treatments for container interiors with organic linings may not be entirely satisfactory since the phosphate coatings may actually decrease the resistance of linings to some hard-to-package products. Apparently, the question of phosphating the container interior must be decided with each particular product to be packaged and possibly with each specific coating used.

• *What is the best weight of the zinc phosphate-type coating to use for container interiors and exteriors?*

This question might be answered differently by different drum manufacturers, depending upon their individual requirements. Certainly, if the drum manufacturer desires a high degree of resistance to reverse impact for his linings, or if he desires to paint the flat sheet and then form the container, he will keep his phosphate-coating weight down.

However, for the very best salt-spray resistance, somewhat heavier coatings seem to be necessary (400 to 500 mg./ft.^{2}). Therefore, some compromise of salt-spray requirements may be necessary if the same phosphate treatment is to be used for both the interior and the exterior of the steel container, or if forming operations follow the painting.

• *How does the iron phosphate-type coating compare with the zinc phosphate type?*

In these tests, the best pretreatments of the iron phosphate type were comparable to the best zinc

Wolverine Trufin*—Type S/T—The integral finned condenser tube—boosted production, kept units on stream longer . . .

Boosting Production of Cracked Gasoline by retubing with Wolverine Trufin Type S/T Condenser Tubing*

THE SITE: A gulf coast refinery
THE WORK: Condensing thermo-cracked straight run gasoline from a re-run tower.
THE UNIT: A pressure distillate overhead condenser

	PRIME SURFACE TUBE	TRUFIN—TYPE S/T
No. of tubes	500	500
Outside surface, Sq. Ft.	1522	3280
Metal	16 BWG Admiralty	16 BWG Admiralty
Tube size	¾" O.D.	¾" O.D.
Shell Side, Flow, Lbs./Hr.	19780	27350
—Temperature in	261° F	261° F
—Temperature out	125° F	101° F
Heat Load, BTU/Hr.	3,960,000	5,820,000

Here is a case where retubing with Wolverine Trufin paid off two ways for a southwestern refinery.

Before the change, it was necessary to pull the prime surface unit for cleaning every 90 days. After Trufin, the cleaning schedule was extended to every eight months!

In addition, more capacity was needed; space, however, was at a premium.

Because Trufin provides more condensing surface per foot of tube this was the easy part of the job. Daily capacity jumped 38%. Condensers—located on a superstructure—required no additional space.

Result: more in-line surface—added production—less bother.

*REG. U. S. PATENT OFFICE

The Facts Speak For Themselves:

With Trufin on the job, condensers and heat exchangers do a bigger job. If you are faced with retubing, specify Trufin—reap similar benefits. It's obtainable in copper (and its alloys), stainless steel, electric-welded steel, aluminum, and bi-metal.

You'll find similar examples of actual case histories in Wolverine's new technical Trufin book. Write today. WOLVERINE TUBE, Division of Calumet & Hecla, Inc., 1443 Central Avenue, Detroit 9, Michigan.

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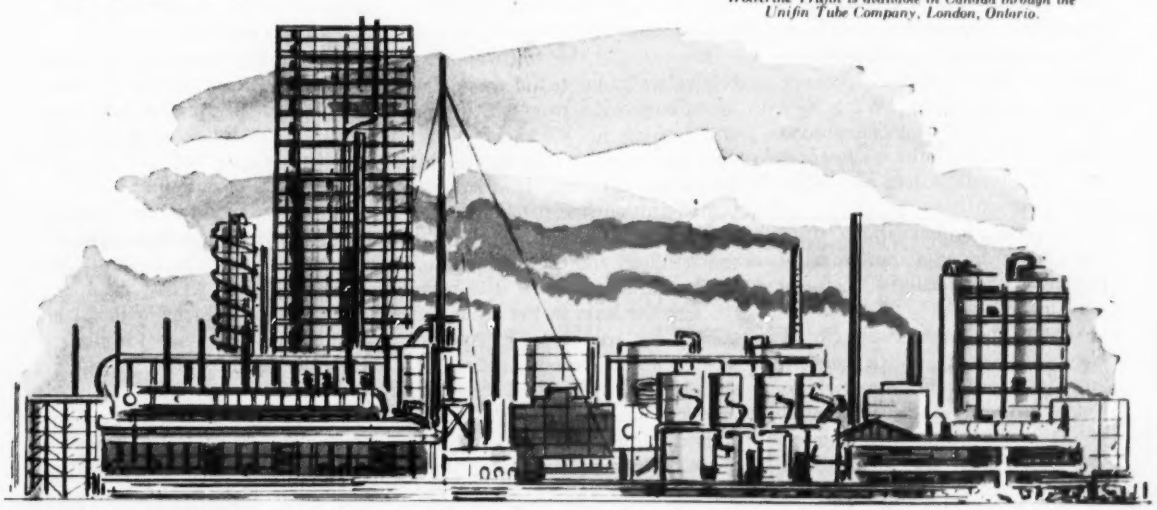
Wolverine Trufin is available in Canada through the Unifin Tube Company, London, Ontario.



PLANTS IN DETROIT, MICHIGAN, AND DECATUR, ALABAMA. SALES OFFICES IN PRINCIPAL CITIES.
EXPORT DEPARTMENT, 13 EAST 40TH STREET, NEW YORK 16, N. Y.

phosphate types on an overall basis. In reverse-impact and ductility tests, they were actually better than the zinc-phosphate coatings.

• How does the phosphate-type scale remover compare with the metal-phosphate treatments?

The phosphate-type scale remover was comparatively poor in salt-spray and humidity tests. Otherwise, it compared rather favorably with the metal-phosphate treatments. It appears to hold considerable value as a simple treatment for hot-rolled steel.

• What are the comparative performances of the phosphate coatings on ordinary and descaled hot-rolled steel?

There seems to be little doubt that scale removal is necessary before phosphating. Phosphate coatings on ordinary hot-rolled steel (with scale) were of little or no value for improving outdoor-exposure performances. Improved outdoor durability is probably the most important reason for using the phosphate treatment. On the other hand, performance was considerably improved by any type of pretreatment which removed the scale.

• What is the effect of the chromic acid rinse?

The chromic acid rinse was necessary for best performance in the salt-spray and water-immersion tests. It seemed to make little difference in outdoor-exposure results.

• How effective are the phosphate coatings for inhibiting corrosion in unlined containers until they are filled?

With but few exceptions, there was less rust on the metal-phosphated panels exposed to high humidity than on either the clean cold-rolled or hot-rolled steel. Therefore, they were generally effective in decreasing the rate of rusting of steel.

The as-received hot and cold-rolled steel, however, rusted considerably less than the cleaned steel, probably because it was protected by an oil or grease film. Rusting on most of the phosphate-treated panels was about comparable to the rusting on the uncleaned steel.

When the interiors of phosphated drums were fogged with protective oil, they were very effectively protected against rusting during storage.

• How do the various phosphate coatings affect the reverse-impact resistance of container linings?

Heavy zinc phosphate coatings impair the reverse-impact resistance of organic linings applied over them. It is difficult to establish a definite maximum-coating weight which will be satisfactory in this respect, although something around 200 mg./ft.^{2} would seem to be satisfactory. Considerably lower weights of phosphate coating would be necessary to withstand forming operations.

• How do the phosphate coatings affect the resistance of container linings to various chemicals?

Considerably more information is needed before this question can be answered. However, it appears that the effect of the phosphate coating is specific with each hard-to-package product.

Salvaging Process Equipment

Extension of the productive life of processing equipment through maintenance impregnation is now an accomplished fact, according to engineers of American Metaseal Manufacturing Corp., West New York, N. J. The Metaseal process completely seals all the microscopic pores in pumps, valves and other cast equipment.

Complete impregnation stops leaks, and in filling up porous areas, prevents concentration cell corrosion in these areas.

Stevens-Thompson Paper Co. of Greenwich, N. Y., had a problem involving a paper mill drying drum which leaked in the area around the journal. Examination showed that this drum had been brazed on the inside to secure the plate, which holds the journal, to the inside of the drum. Because of its size, the drum itself was used as the impregnating vessel.

Processing started with draining residual water from the drum, followed by pressurization with steam, and a check for leaks. Then vacuum was pulled and the impregnant drawn in. The stress involved prevented any outside patching.

Steam was introduced into the drum to heat and exert pressure on the impregnant, causing it to come through the leaks in the drum and around the trunion. This process was continued until all leaks stopped. A careful check for leaks revealed successful impregnation.

The impregnant was pumped out with steam pressure, after which the drum was washed, using a fire-hose through the manhole. After replacing the manhole cover, steam was introduced to heat the drum again, then quickly drained. With the cover again removed, compressed air was played over the hot metal to dry the section where leakage had occurred.

Finally, the cover was replaced, the drum pressurized with steam and a final check for leaks was made. None were found and the machine was turned over to production for operation.

Recently, maintenance impregnation salvaged another piece of equipment at Felt Process Co., Jamaica Plain, Mass. A drying drum, 48 in. diameter with 60 in. face, leaked sufficiently to interfere with the drying.

A similar process was used.

According to a Felt Process Co. spokesman, there is no sign of a leak, after four months, and the machine has been used continually for production.

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Hooker uniformity can be your key to a smoother-running operation. It lets you keep methods constant, with consistent results. Carload after carload, month after month, Hooker caustic soda is the same—always what you expect it to be.

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Containers: Tank cars • Tank wagons • Barges • Drums

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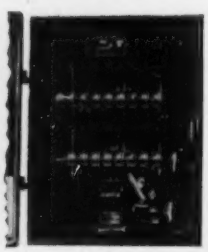

3. Automatic sequencing of batch operations. The Taylor FLEX-O-TIMER* Time Cycle Controller "does its own thinking"—takes care of as many as 36 operations automatically. Provides automatic timing of the sequence and duration of processing operations involving temperature, pressure, mechanical motion, electrical energy or combinations of each—precisely in accordance with a pre-determined schedule. Provides push-button operation for such jobs as: hydraulic press operation; batch charging and dumping; plastic molding operations; hydrogenation of edible oils and fats; dry ice molding; backwashing of catalyst and filter beds, etc.

4. Lifetime high accuracy in laboratory, routine testing. The name Taylor is your protection on etched stem thermometers and hydrometers. A.S.T.M.'s, Plain, Armored or Pocket-Type-thermometers are precision built and designed for maximum readability. Expertly annealed for minimum breakage. Specially aged before pointing and graduating for permanent accuracy.

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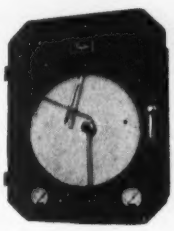
World's Temperature -

and that's not all . . . There are Taylor instruments for indicating, recording and controlling pressure, flow, liquid level, speed, load, density and humidity as well as temperature. We can supply you with a matched set of ASTM precision thermometers, or a completely-equipped graphic panel. And throughout the U. S. A., Canada, Australia, Europe, Latin America and many other parts of the world there are Taylor trained Field Engineers to help you with your instrumentation problems. Write for the name of your local man to Taylor Instrument Companies, Rochester, N. Y.

1. Graphic Panels requiring miniature instrumentation. The rapid advances of automation in recent years have necessitated the development of the graphic panel—and consequently miniature instrumentation. Taylor was one of the first in this field and the well known TRANSET* System carries many refinements of design based on actual field experience. For example, the need for more accurate measuring devices, due to separation of the functions of measurement and/or control and indication or recording, led to the use of the force-balance principle in transmitters. Thus the small power generated by minute changes of measurement can be transmitted with high accuracy to receivers. Taylor also contributed the TRANSET Plug-In Controllers and Receivers which reduce panel size, simplify mounting, mean fewer piping connections, easier maintenance and lower labor and material costs—*at no premium to you!*

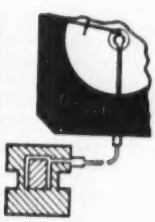


2. Complete local or point of measurement control. Fifteen years of unparalleled performance on all types of control problems have established the FULSCOPE* Controller as pre-eminent in accuracy, dependability and economy of operation. It is extremely versatile because the same control mechanisms are available for temperature, pressure, flow and liquid level—in either recording or indicating models, as locally mounted controllers, transmitters or controlling receivers. Interchangeable unit construction permits a small inventory of parts. Pre-calibrated units eliminate expensive checking. Easy accessibility means minimum down time. And the FULSCOPE Controller is adaptable to any control problem because of three control effects: Proportional Response, Automatic Reset Response, and PRE-ACT* Response (rate action) . . . another Taylor "first".

5. Dependable Non-Indicating Controllers for routine applications. The Taylor *Self-Acting Temperature Controller* (shown) is ideal for any process where air or electricity is not available and where "on the nose" control is not absolutely essential. Many ranges between 10° and 610°F. Can be used for valves up to 2"—direct or reverse acting.

The Taylor Type-P *Expansion Stem Temperature Controller* is designed for applications where "on-off" control is acceptable and where there's space for the 12" or 15" rigid expansion stem. Air operated: control point easily changed.

For simple pressure applications the Taylor *10RF Non-Indicating Controller* is available in direct or reverse-acting types. Air operated; sturdily built; inexpensive.



6. Simple, economical measurement of load or force. Taylor Volumetric Load Measuring Elements are rugged, self-contained units for measuring force *directly* on the chart or scale of a recording or indicating instrument. No auxiliary source of power is required. This is one of the simplest methods of determining tension, compression loads and combinations or both on most any type of equipment. The paper and textile industries have proved their design, accuracy and performance over many years, and recent developments have extended their utility to many other applications such as: measuring tension on conveyor belts; film tension; thrust on bearings; forces applied by pneumatic or hydraulic cylinders on squeeze rolls; weight of suspended solids or corrosive liquids in tanks, and force applied on testing apparatus.

Taylor Instruments MEAN ACCURACY FIRST

You vs. the Man in the Street

- **What does he think of you?**
- **How important are his opinions?**
- **What can be done about his beliefs?**

ACTUALLY, the man in the street has a pretty high opinion of chemical engineers and chemical engineering. Only trouble is that he really has no idea of what a chemical engineer is or what he does.

That's the gist of a recently completed study by Victor E. Muniec, Malcolm Klein and Dr. Nathan Maccoby of the School of Public Relations and Communications of Boston University. These gentlemen surveyed a group of 750 better-than-average high school graduates, and came up with a few findings which you can extrapolate to include most of the population.

These findings bear directly on your job security and even on your paycheck.

NEXT MONTH . . .

Looking for a way to become a more effective engineer. One sure way is to learn to be a better problem solver. To do this you'll need a definite approach to problem solving—one that works. Look for one in next month's YOU AND YOUR JOB.

How You Look to the Man in the Street

- **Who's looking at you?**
- **What does he see?**
- **What does he think?**

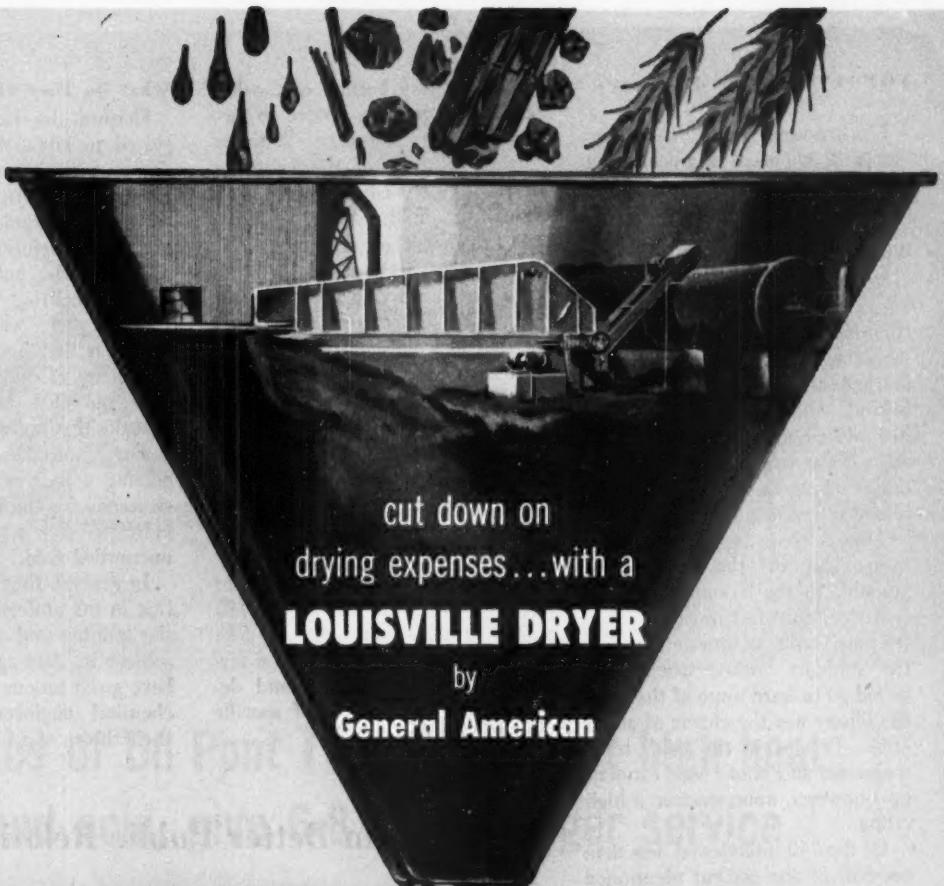
First off, let's find out something about the people interviewed.

All were freshmen in the various schools of Boston University—about a third were women. Approximately 75% of the students interviewed were 19 or younger. But almost 20% were over 21—nearly all veterans.

Though young, these people were already better educated than the national average. Their parents too had a somewhat better-than-usual education—about 70% of the fathers and 75% of the mothers finished high school and many had gone on to college.

The vast majority of the interviewed came from families with an annual income of over $4,000.* About half worked during the school year.

* Some 35% either stated that they did not know the family income or did not answer the question.



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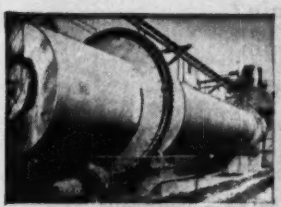
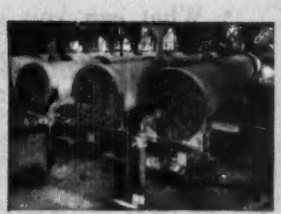


Louisville Rotary Cooler with rotary shell and external water sprays.



Louisville Rotary Steam-Tube Dryer —indirect type using steam as heating medium, and utilizing 85% of that steam for useful work.

There is a LOUISVILLE DRYER for better drying in the following industries: Brewing • Canners By-Products Chemical • Distilling • Fertilizer • Fisheries • Feeds • Foods Mining • Packing House Products • Wood Products

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Know the results before you buy!

A Louisville engineer can tell you every saving, every improvement, every bit of increased efficiency *before* you invest. A Louisville Dryer is fitted to your job. It's the result of a Louisville engineer's complete analysis of your particular problem, of *knowing* your problem thoroughly... and solving it by applying 50 years of drying experience, and using the testing facilities of General American's laboratories.

More than once, a Louisville Dryer has turned a losing operation into a profitable one. Write or call for a Louisville engineer to make an obligation-free survey of your operation.

Few reported any first-hand contact with chemical engineers, but nearly all had heard of the field at one time or another.

Where Did They Look?

Some 37% list newspapers as the biggest source of information on chemical engineering, with popular magazines, school classes, trade journals and friends coming close behind. About 10% said that they had picked up no information at all. Of the other 90%, about two out of three feel that the field is relatively unknown.

This is some indication of the meagerness of the information available to the layman.

A significant fact was revealed in the next series of questions asked the students. Asked where they would go to learn more of the field, the library was the choice of about 30%. Persons in the field, trade magazines and books were runners-up—however, none received a high rating.

Of the 750 interviewed, less than one-half of one percent mentioned the American Chemical Society and none listed the American Institute of Chemical Engineers as a place to find information on chemical engineering. Whether these organizations are even known to high school students is questionable.

Remember, that compared to the general population these college men and women were a pretty "savvy" group. Most had breezed through high school with grades over 80. Therefore, if anyone could be expected to have a fairly accurate idea of just what chemical engineering is and what the chemical engineer does, they could.

See if you think they do.

How Do They See You?

The majority of the group regard the chemical engineer as the stereotyped "scientist" of fiction and the movies—a highly intelligent, very "busy" introvert who works in a laboratory doing God-only-knows what.

The students place interest in people, ability to get along with people and understanding of people at the very bottom of the list of personal qualities needed to succeed in the profession. This is further evidence of the existence of the stereotyped, Hollywoodized "engineer" in the minds of most.

Virtually all guessed that a college degree was practically prerequisite to entering the field, and many felt that two or more years of study beyond college is needed. But darn few could tell you what the chemical engineer studies in school or does on the job—or even what the profession and its members have accomplished.

In fact, when asked to list some of the specific achievements of chemical engineers, 65% could think of none. Some 10% credited atomic energy to the ChE, 11% listed synthetics and plastics, 7% said medical advances and a few mentioned clothing, war and defense and a sprinkling of specific products.

What Do They Think of You?

Despite the fact that few appeared to know very much about chemical engineering, the profession enjoys a pretty good reputation.

About two-thirds believe that the chemical engineer will respond readily to the public needs. The majority feel that the chemical engineer is pretty well paid for whatever it is that he does, that there are plenty of opportunities in the field and that the profession is virtually depression-proof.

They consider chemical engineering a progressive field, highly respected by the public. For the individual they see an unrestricted, uncrowded field.

In general, they feel that a position in the profession is well worth the training and work required to achieve it. And approximately 8% have given serious consideration to chemical engineering in making their choice of a future occupation.

Profit From Better Public Relations

- **What can you gain?**
- **Where do we begin?**
- **What has to be done?**

Despite the fine reputation which the profession appears to enjoy, there is little doubt that chemical engineering—in fact, engineering itself—is virtually the unknown profession so far as the general public is concerned.

It seems ironic that, living in the midst of an engineering civilization and literally surrounded by the handiwork of the engineer, the man in the street has only the foggiest notion of what an engineer is or what he does. He knows that doctors can make him well; lawyers will help him out of trouble; mechanics will fix his car and bankers will loan him money. Engineers? "With what railroad?"

Fortunately, the engineering societies and many individual engineers are increasingly aware of the fact that the profession itself is responsible for this ignorance of its place and its achievements, and that it must take the lead in the difficult task of education that lies before it.

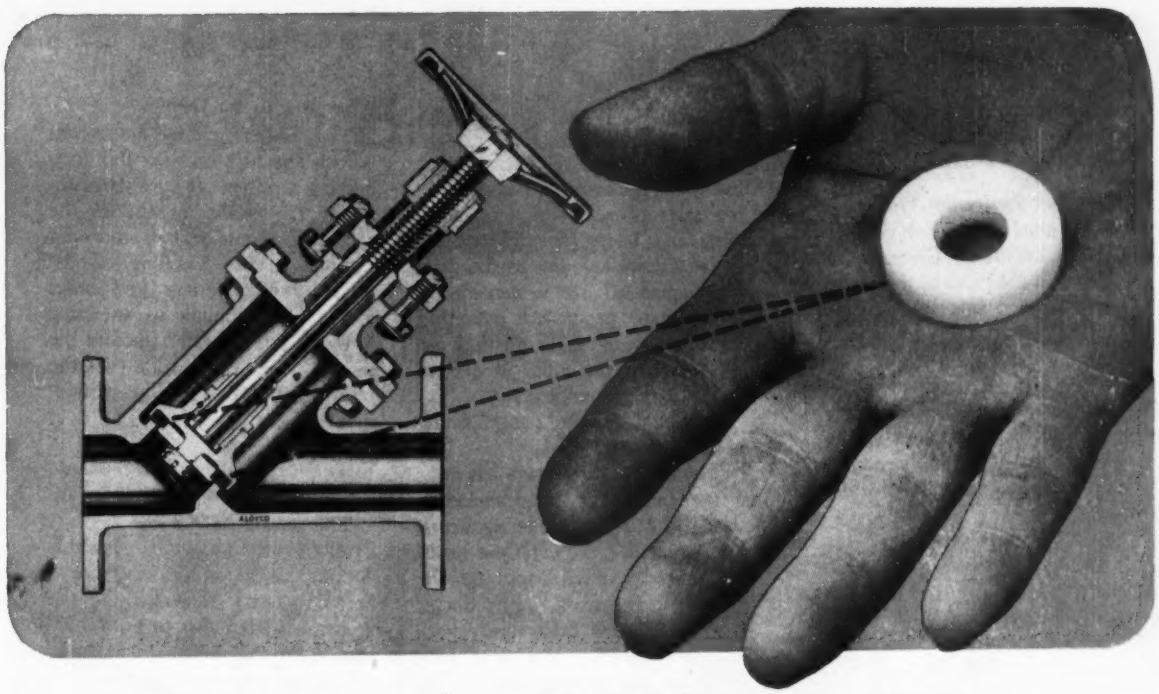
What You Gain Personally

But don't get me wrong. This job of "educating the masses" is no one-sided, philanthropic proposition. Since public opinion is a force to be reckoned with, both the individual engineer and the whole profession stand to benefit from doing the job.

The individual engineer gains

- Greater personal prestige in the community.
- Better understanding for his work and greater appreciation of its worth.
- Higher salary and increased job security.

This last is no pipe-dream. It is an offshoot of the wider appreciation of the work and the worth of the chemical engineer. The squeaking wheel gets the grease—and the person whose work is both known



Discs of Du Pont TEFLON® resist high heat and acid, give 6-8 times longer service

Processors can reduce downtime maintenance costs with "Teflon"

In one chemical plant, Y-valve discs for fatty acid service at temperatures up to 475°F. were a source of trouble. They would deform and wear down in short order, making tight sealing against vacuum impossible. After switching to renewable discs of "Teflon,"* the manufacturer increased service life for these parts 6 to 8 times. Maintenance time and costs have been considerably reduced, valve operation is more efficient.

Why is the service performance of "Teflon" so remarkable? Its coefficient of friction is extremely low and stays constant through changes in temperature. It has good impact strength and abrasion-resistance under normal conditions of speed and load. Toughness and flexibility are retained at temperatures as low as —450°F. Continuous service up to 500°F. is possible. "Teflon" has zero water absorption — won't shrink, swell, crack or harden in moisture. To climax this remarkable set of properties, "Teflon" is inert to *all* chemicals except molten alkali metals and fluorine at high temperatures and pressures.

Have you investigated the properties of "Teflon" and the other members of the Du Pont family of engineering materials — "Alathon"* polyethylene resin, "Zytel"† nylon resin and "Lucite"* acrylic resin? For further information on the properties and uses of these materials, mail the coupon below.

(Valves and discs manufactured by Alloy Steel Products Co., Linden, New Jersey)

Registered trade-mark of E. I. du Pont de Nemours & Co. (Inc.)
†"Zytel" is the new trade-mark for Du Pont nylon resin.

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Please send me more information on Du Pont "Teflon" tetrafluoroethylene resin: Uses ☐; Processing Techniques ☐; Properties ☐. I am also interested in receiving more information on: "Zytel" nylon resin ☐; "Alathon" polyethylene resin ☐; "Lucite" acrylic resin ☐.

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*Title*_____
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*State*_____
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and appreciated can expect a return that is commensurate to the known value of his work.

How the Profession Profits

So much for the direct benefits to the individual. However, he also shares in the gains of the profession as a whole. Increased recognition of the profession and its value means

- Greater ease in attracting competent men to carry on the work of the profession.
- Increased public confidence in its views on matters which effect it.
- Sympathetic support of the general public should the need arise to plead the causes of the engineer. (Witness the support given the medical profession in its fight against socialized medicine.)

How We Have a Head-Start

Fortunately, the engineering profession is off to a running start in any effort to educate the public on the work of engineers and their value to the community.

We have little to live down. The "quack" that haunts the medical profession; the "shyster" that harries lawyers; the "shylock" that dogs the banking profession and similar symbols of the worst in other professions have no counterpart in engineering.

Further, we have no particular axe to grind. The job of telling our story need not be a job of propaganda. And with no repair job to do we can start immediately on the positive side.

How to Take Advantage of It

There can be no doubt that the public has an interest in technical subjects—when they are properly presented.

The "do-it-yourself" craze that has swept the country, the astounding sales of science-fiction magazines and books, the lengthening list of science columns in the daily newspapers all are evidence that many, many people are interested in technical material. All they ask is that it be presented in a form which they can understand.

It should also be a form which excites interest.

The medical profession has done a tremendous job of dramatizing itself—the rigorous training necessary to qualify, the extensive medical research which backs up the physician, the work of the doctor himself and his high standing in the community. And they have done the job with dignity.

Physical scientists, too, have told their story in terms of human interest and public benefit and have gained the confidence of a great segment of the public.

Engineers should give the same treatment to engineering. There is much in engineering that is exciting and imaginative, and a good engineer can talk about these without "razzle-dazzle"—but with enthusiasm. Trouble is, many lay groups report, that trying to get an engineer to speak before them and discuss engineering with them is like trying to lasso a hummingbird.

Either they can't get an engineer to appear or they get a fellow so dull and pedantic that they give up on the idea of learning anything about engineers or engineering.

There isn't much of an excuse for either situation. But the remedy is strictly up to us.

What Has to Be Done

The job has to be done in two parts. The first involves the engineering societies. It consists of focusing the public interest on the accomplishments of the profession through proper handling of the publicity of meetings and other events, and, through an unending program of appearances before the public, calling attention to the training, the work and the achievements of the engineer.

Most of the societies have already embarked on such a program, with impressive results.

The second half of the solution involves you directly. It means becoming aware of the need for a better general understanding of your work—and also, of how you'll gain from this better understanding. It means helping the societies in their job of distributing information. And it means taking a bigger role in community life.

This last point is most important. It is here that the individual engineer can exert his biggest influence and, while helping the community, gain a great deal personally and for his profession. It is the individual doctor's history of service to the community and of participation in local affairs that commands respect when he speaks.

To their own detriment, engineers have too long hid their light under a bushel. As A. C. Monteith, recently elected head of the American Institue of Electrical Engineers, has said: "We do a wonderful job of running the slide rule, but only a fair job of interpreting what we are doing to the man who benefits from our labors. We take too much for granted."

BETTER OPERATORS . . . *Through Schooling*

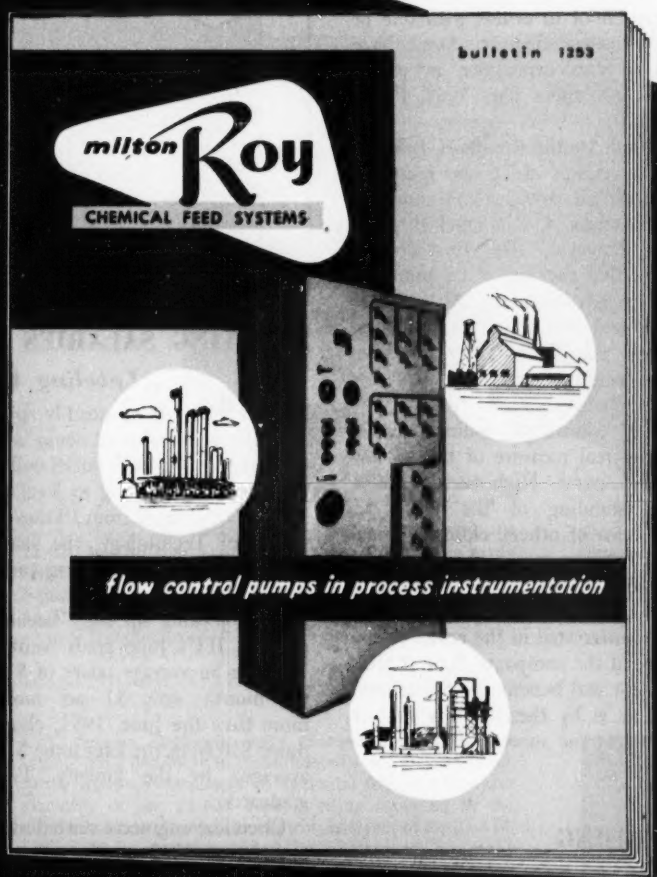
One sure way to get better plant operators is to instruct the ones you have—instruct them in all the ins and outs of their own job, and give them a well-rounded knowledge of the company's operations and the workings of the industry.

This is the aim of one of today's most unique educational institutions—the Crown Zellerbach Paper School at Camas, Wash. Nowhere in the world could you find a 750-ton integrated specialty pulp and paper mill fulfilling the function of a school laboratory. And no other institution can boast of its own textbook and motion pictures in color covering all phases of its curriculum.

▶ **All the Ins and Outs**—Present curriculum ranges all the way from a movie on the "History and Romance of Paper" to a discussion of quality control. Typical subjects, picked at random from the class schedule, show the variety and extent of the instruction, these include: fundamental chemistry, labor

new bulletin

flow control pumps in process instrumentation



New 24 page Bulletin describes and illustrates the application of Flow Control Pumps to chemical feed and complete instrumentation systems.

- Describes various types of controlled volume pumps — how they work, what they do.
- Contains 25 flow diagrams of typical systems including applications in the paper, petroleum, chemical, water treating and other industries.
- Includes engineering data on Flow Control Pumps — their operation and selection.

This Milton Roy HANDBOOK will be a valuable addition to your industrial library. Write for your copy, today!

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See the MILTON ROY EXHIBIT — BOOTHS 131-136, First International Instrument Congress and Exposition, PHILADELPHIA — SEPTEMBER 13-24, 1954

relations, logging operations, chemical pulping, mill maintenance, instrumentation, evaporation, paper machines and wage economics of the paper industry (this last presented by competent union officials).

Instruction, for the most part, is given by mill superintendents, foreman and company officials. Therefore, the material presented is often the result of years of practical operating experience—shared by men who know a great deal about pulp and paper, but who would ordinarily publish nothing.

But the more academic side is not neglected. Instructors are also recruited from nearby schools, such as the University of Washington and Oregon State College, to lecture in their field of specialty.

▶ **How It's Set Up**—In operation for over 20 years, the school is now set up as a four year course. In the first year, the student is grounded in the fundamentals of papermaking, supplemented by movies of the complete mill operations. In the second year, mill operations are gone into more detail, supplemented again by motion picture, and also by guided mill visits.

Third and fourth years represent a departure from the previous two. Individual study in the plant and round-table discussions with plant supervisors and foremen replace the more formalized program. The few lectures that are given are generally presented by people from outside of the company, and are designed to provide new information and a broader perspective of the paper and allied industries.

The latter years also mark a change in the method of examining the students. In the first two years, students are examined regularly through written examinations of the "open book" variety. Third and fourth year students are expected to write comprehensively on any papermaking process or operation without recourse to notes or text.

Classes for all four years are held outside of company time. And both students and instructors give of their own time voluntarily.

▶ **Who Are Eligible**—All employees of the company are permitted to apply for admittance to the school. The one stipulation is that they must work in a division which is near enough to Camas that they can attend classes.

Women employees are permitted to enroll for the first two years only—the final years are more intimately involved with plant operations and women are not employed in that field.

Students represent a wide variation in both educational and industrial backgrounds. They range from those who did not complete high school to others with one or more college degrees. Some have many years experience in papermaking; others have only a few months.

▶ **What Are the Results**—Graduates of the course are to be found at virtually all strata of the company organization. C-Z is quick to point out, however, that this doesn't mean that the course is a prerequisite to advancement. Although it does feel that those fellows who go to school are the same ones who would be likely prospects for higher jobs anyway.

C-Z counts the indirect results as the real measure of the success of the course. High morale, better understanding of the jobs and problems of others, closer cooperation between men and between departments, better operators—more highly skilled, more knowledgeable, more interested in the entire operations of the company—these it feels are the real benefits of the school, and it is by these results that it measures the success of the operation.

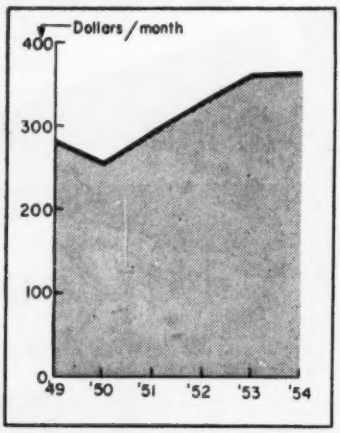
READING

. . . *To Stimulate Growth*

As part of its program to stimulate young engineers to use their own initiative and "grow" professionally, the Engineering Society of Cincinnati has made some 80 outstanding books available to the young engineers of that area.

In cooperation with the public library, selected volumes in such fields as natural science, philosophy, psychology, history, fiction, economics, sociology and business management have been secured for the use of young engineers.

Books were chosen from the "Reading List for Young Engineers," published by the Engineer's Council for Professional Development.



STARTING SALARIES

. . . *Leveling Off*

After a decade of steadily spiraling starting salaries, it looks as if the pay rate for fresh-out-of-college engineers is beginning to level off.

That's the word from Illinois Institute of Technology, the school with the largest engineering enrollment in the country.

After picking up their bachelor degrees, IIT's June grads went to work for an average salary of $363 per month, only $1 per month more than the June, 1953, class—down $10 from the handsome $373 averaged by the January, 1954, graduates.

Chemical engineers started at an average of $362 per month—up $10 from last year's $352, but down quite a bit from January's all-time high of $394.

Because most IIT graduates have had more work experience than the average college engineering graduate, starting salaries generally run about $20 per month higher than the national average.

For More YOU AND YOUR JOB See Page 252 ➡

CEC increases the scope of industrial mass spectrometry through two great instruments for process monitoring and control

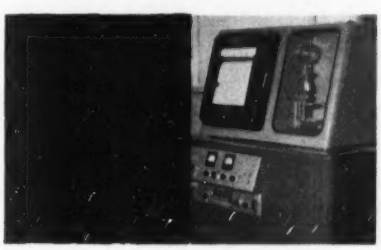
Consolidated's Model 21-610 mass-spectrometer and its companion, the new Model 21-620, far excel all other instruments of comparable price in performance capabilities and reliability in industrial environment. The extreme sensitivity of the 21-610—accurate to a few parts per million—qualify it for highly critical purity studies as well as process monitoring and control applications. Fitted with an accessory hand-held probe, either model serves as a leak detector for any gas within its mass-range. The 21-620's resolving power up to mass 150 further extends the applicability of an industrial mass-spectrometer to research laboratories and medical centers, as well as to plants of chemical, petro-chemical, petroleum and gas industries. Nearly identical in appearance, the 21-610 features the Diatron ion analyzer and the 21-620, a new cycloidal focusing analyzer.

21-620 Except for slightly less sensitivity, the 21-620 has all the capabilities of the 21-610 plus many others. Where the task is to analyze "heavy" gases or liquids, either in plant locations or in the laboratory, the 21-620 process monitor mass-spectrometer is the ideal control instrument.

21-610 The 21-610 is completely self-contained, needing only 110 volts and a small quantity of cooling water for operation. Moderately priced, easily movable, and economical to operate, the 21-610 is industry's ideal instrument for chemical research, process control and leak detection.

CEC Service Engineers quick change of ion analyzers (right) adds flexibility to Consolidated's two process monitoring mass-spectrometers. A cycloidal focusing analyzer assembly of the 21-620 type is being mounted in the vacuum rack in place of the Diatron analyzer of the 21-610.

The basic instrument can be augmented by many available accessories, thus broadening its application scope. At the far right, are a gas or light-liquid sample inlet system and chart recorder.



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Investigate the application of industrial mass-spectrometry to your business. For full details about CEC's two companion process monitoring mass-spectrometers, send for Bulletin CEC 1824A-X3.

A NEW BOOTSTRAP TO . . .

Pull Yourself to the Top

How to get expert guidance—tailor-made to your needs—in the business and managerial problems of the chemical industry.

Got your sights set on a top job in the chemical industry? As you well know, you'll need lots of guidance and plenty of help to get it.

Your technical training has given you a good start in that direction. It's taught you how to think logically, you've learned (probably the hard way) how to study, and you've a pretty good notion of just what makes a chemical process or operation tick. The job that lies ahead involves learning the fundamentals and operations of management.

This is a big job, but it's been made a whale of a lot easier for you by the late Dr. John H. Perry and a staff of 125 specialists in the various phases of business. You see, Dr. Perry's new book,* "Chemical Business Handbook," was written with your problem in mind.

In One Book, the Works

There are hundreds of books that can give you information on a specific topic—say, finance, or advertising, or personnel. But the new "Perry" is a book, a single book, which can give you the fundamentals—and the vocabulary—of these and all other phases of business and still be right there on your shelf to answer specific questions.

Questions like: "How does the capital structure of a chemical company affect the average cost of new money?" or "What tests can I use to tell if this advertising copy is any good?" or "How can I set up a program to train operators?"

And there's more, lots more. In one section, a group of DuPont accountants and chemical engineers summarize modern methods and techniques of cost accounting and planning. And discuss how management determines the causes of good or bad operating results.

All Precincts Heard From

Production, in all of its ramifications, is covered by W. L. Williams of DuPont, Dave Pierce of Diamond Alkali and seven others. This section goes from raw materials to waste disposal—and touches all the bases.

Have you had a chance to absorb some business law? In the CBH, C. B. Dutton, a practicing attorney in Indianapolis, explains the common legal concepts which guide management in running a business within the law. Sure, your company has a legal department. But to reach the top in any business you had better know enough about the law that your legal department won't have to spend its time bailing the company out of jams caused by your blunders.

Have you enough insurance? On a personal basis that's strictly up to you, you won't lose your job if you don't. But if you had to answer the same question for your company, it's in a brand new light. Here again, you can probably tap a specialist on the shoulder and he'll come up with an answer, but in that top job you have your eye on you'll have to evaluate his answer. And you'll have that empty feeling in your wallet if you don't have more than a nodding acquaintance with industrial insurance and the relationship of cost to protection. Better check chapter 18 in the CBH, and bone up.

Talking Your Language

The whole panorama of the chemical business from purchasing to sales is discussed in a way that you can understand. Dr. Perry took pains in editing the volume to keep every discussion in the language of the chemical engineer. Unfamiliar terms are highlighted and immediately explained. This is an advantage whether you use the book to broaden your knowledge and learn of fields outside of your specialty, or whether you merely turn to it for the answer to a particular problem.

Whether you've a long way to go to the top, or only a few steps, it's a safe bet that the "Chemical Business Handbook" will help you get there. And help you do a better, more intelligent job when you arrive.

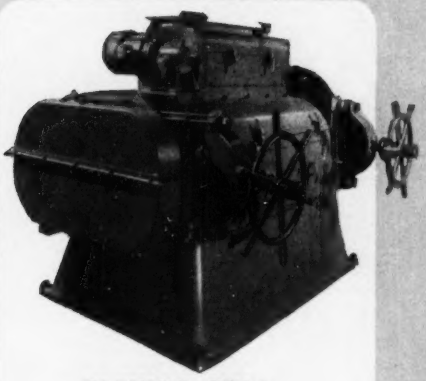
* "Chemical Business Handbook," edited by John H. Perry, McGraw-Hill, New York, 1,330 pages, $17.

A Dream Fulfilled

Those of us who really knew and worked most closely with the late Dr. John H. Perry feel that this "Chemical Business Handbook" is the culmination of his greatest dream. His "Chemical Engineers' Handbook", in its three editions, had already helped thousands of engineers to advance in their chosen profession. But Jack Perry clearly recognized, especially in recent years, the increasing need for a companion volume to help ease the entry of technical men into more responsible positions in industrial management. So, with characteristic vigor and thoroughness, he planned this pioneering effort to bring together in one volume the basic information and reference data on business practices in the chemical process industries.

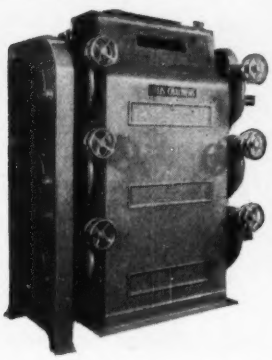
Its twenty chapters and 1,330 tightly packed pages represent the carefully edited work of 125 leading authorities and specialists in all phases of industrial management. Now, as a result of Perry's vision and enterprise, the man who wants to get ahead in the chemical business can turn to his personal bookshelf for a single source of useful, authoritative information on all the many important phases of business that lie beyond his immediate skill or specialty. If in the process of putting its facts and figures to work, this handbook helps to make more efficient and better rewarded managers in the chemical industries, Jack Perry's fondest hopes will have been fulfilled.—S. D. Kirkpatrick

ALLIS-CHALMERS Reduction and Separation Equipment



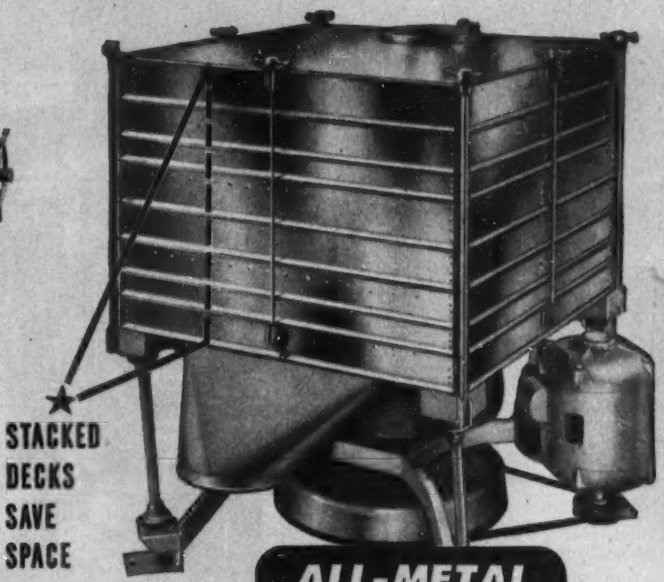
FLAKING MILL

By compacting mill feed into broad-surfaced flakes, the Allis-Chalmers flaking mill speeds your subsequent grinding operation *two to four* times. The principle is basic . . . flakes shatter much easier than other forms of material. A complete line of Allis-Chalmers flaking mills is available to meet any chemical industry requirement.



Style N ROLLER MILLS

In this Allis-Chalmers roller mill, three progressively finer grindings produce a maximum yield in a single pass. Each grinding is extremely gentle. There is no excessive shattering, no size destroying impact. Fines are kept to minimum. To meet varying requirements, Style N roller mills are also available in one pair high and two pair high types.



STACKED DECKS SAVE SPACE

ALL-METAL CIRCLE SIFTER

35 Square Feet of Screening Area in NINE Square Feet of Floor Space

IF YOUR PLANT EXPANSION PROGRAM is running a losing race against increasing production, consider installing the compact, high-capacity *Circle* sifter. By utilizing stacked decks, this space-saving unit provides screening area equal to that of a single deck screen requiring *four times* the floor space.

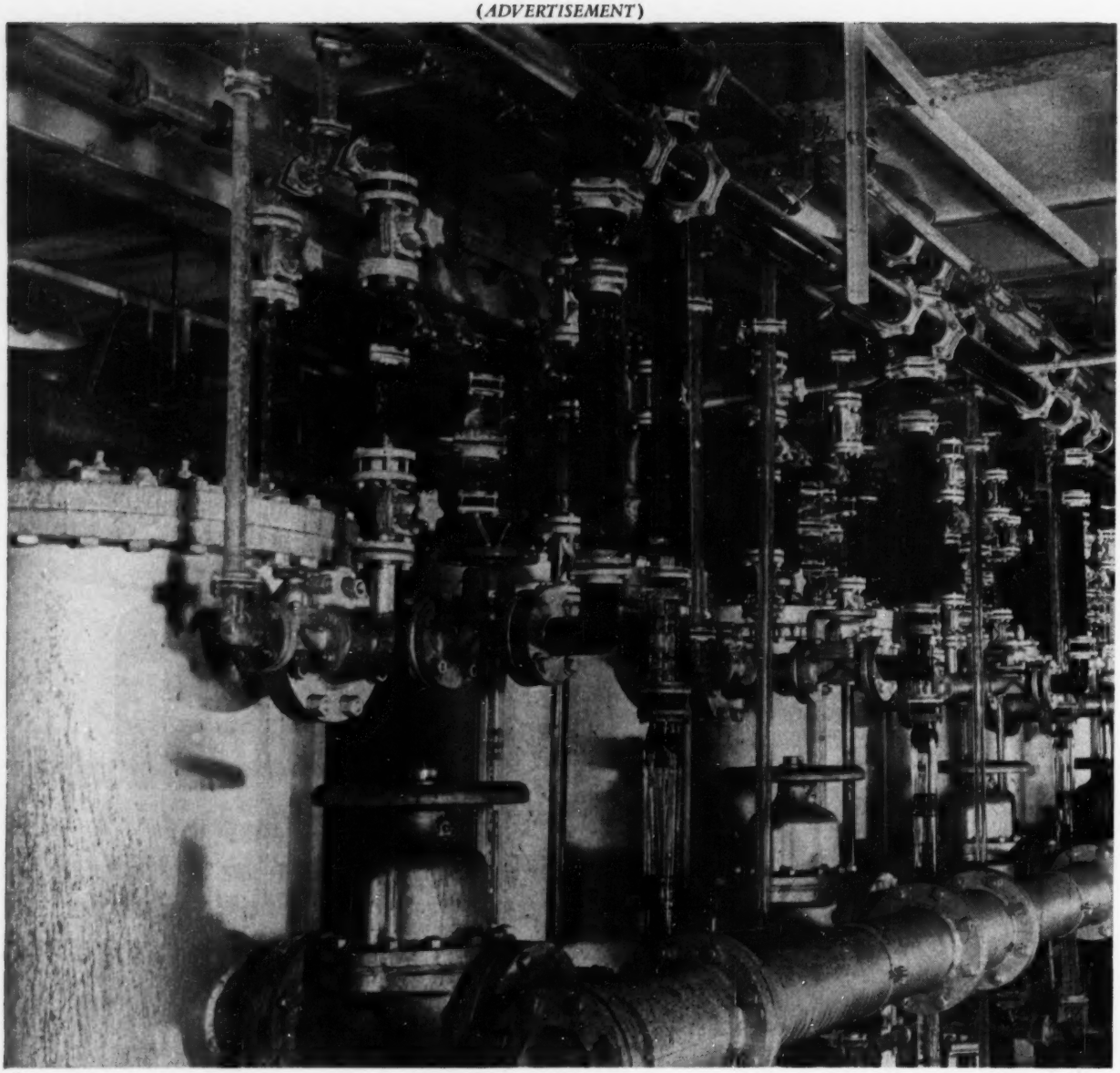
Other advantages of the stacked deck design include flexible capacity, quick product changeover and positive method of tensioning screen. Three to seven metal or silk screens may be used to meet varying production needs. External tie-rods speed deck changing. Simplified dismantling and all-metal construction facilitate fast, thorough cleaning with air, water or brush.

Installation requires no structural modification. Dynamic balancing makes the *Circle* sifter's gyratory motion smooth and vibrationless. Contact your nearby A-C representative or write for Bulletin 06B7625A, Allis-Chalmers, Milwaukee 1, Wisconsin. A-4215

Circle is an Allis-Chalmers trademark.

ALLIS-CHALMERS

Chemical Milling and Processing Equipment



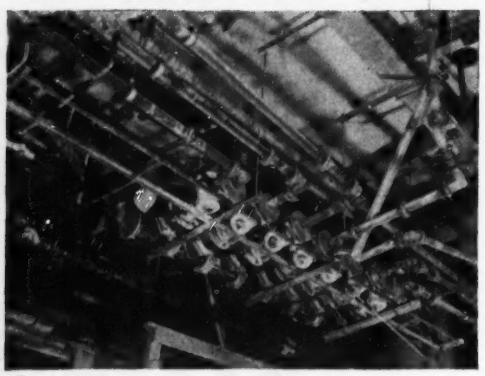
1

Picture 1—This section of BECCO's complex PYREX brand glass pipe installation shows hookup to metal valves with ASME flanges, and well-designed hanger arrangements. A second plant in the Northwest has duplicate installations.

Picture 2—PYREX brand glass pipe is easy to install. Note independent support (A) for valve in vertical glass line. BECCO pipefitters not only install new lines, but reinstall old lines to meet new processing requirements. Some pipe in this plant is over 20 years old and shows no sign of wearing out.

Picture 3—Delicate chemicals are safe in PYREX brand pipe. It is impervious to corrosion. Hard and smooth, it cannot contaminate. Takes temperatures up to 250° F. Cleans with live steam and cold water.

2



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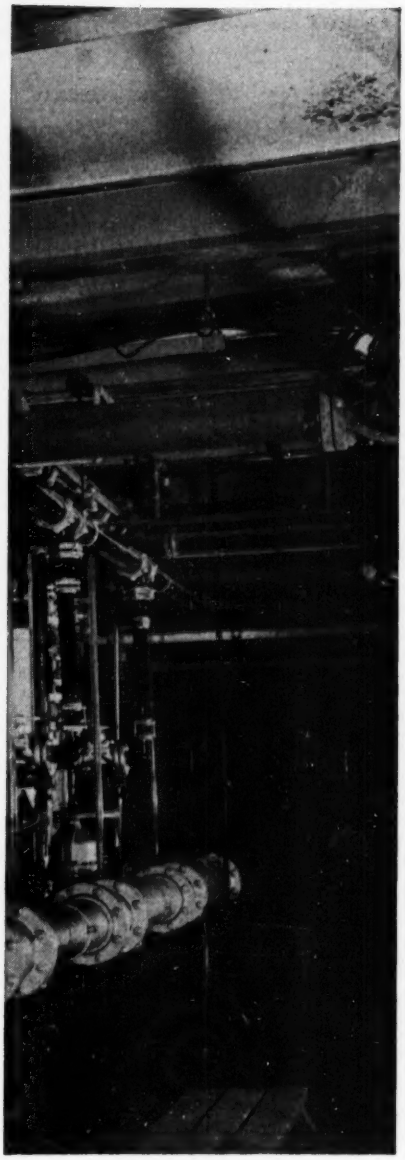

Some of this PYREX® pipe has been **working for 20 years**

Over twenty years ago Buffalo Electrochemical Company, Division of Food Machinery and Chemical Corp., well-known producer of hydrogen peroxide, found PYREX brand glass pipe the permanent answer to two process piping problems: corrosion, and product contamination.

Today, thousands of feet of PYREX brand pipe make up a complex liquid-handling system linking all of BECCO's production operations.

The sensitive chemicals are safe in glass and the glass is safe from chemical attack. The glass is unaffected by all acids (except hydrofluoric). PYREX brand pipe carrying 5% hydrochloric acid at 212° F., for example, loses only .0003" of thickness a year. (It would take over 200 years at that rate to eat away only 30% of the pipe wall.)

And the smooth hard surface of glass discourages buildup of contaminating residues. It's easy to clean and you can *see* when it's clean. Trouble can't hide behind glass.

BECCO's experience parallels the experience of nearly all chemical companies who have given PYREX brand pipe a try.

First they overcome their natural fear of breakage sufficiently to make a cautious trial installation. They discover sharp reductions in corrosion and maintenance losses—and complete freedom from product contamination.

Then, they find that PYREX brand pipe is not the fragile thing they suspected. It stands much more rugged handling than they're likely to give it and it's easy to install. (As in most plants, BECCO's own pipefitters handle all PYREX brand pipe installations and changeovers.)

We would welcome a chance to talk with you about the savings that are inherent in the use of PYREX brand glass pipe. Meanwhile the coupon below is for your convenience in sending for more detailed information.

Bulletin EA-1 pictures and describes many process industry installations. Bulletin EA-3 catalogs what we have to offer by way of pipe and fittings. Bulletin PE-3 tells how to lay it out, hang it, plumb it. We'll be glad to send you any or all of these informative booklets.

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Corning means research in Glass

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- ☐ EA-1: "PYREX Pipe in the Process Industries."
- ☐ EA-3: "PYREX brand 'Double-Tough' Glass Pipe and Fittings."
- ☐ PE-3: "Installation Manual for PYREX brand Glass Pipe."

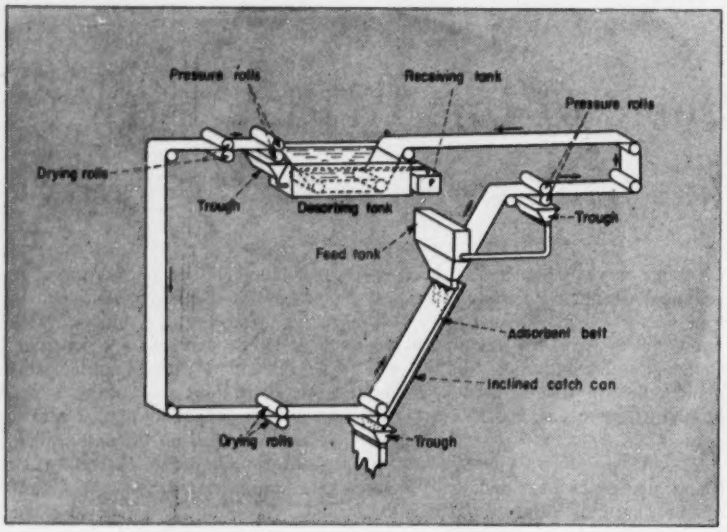
Name..... Title.....

Company.....

Address.....

City..... Zone..... State.....

NEW EQUIPMENT PATENTS . . .



Chromatography Comes of Age

Continuous belt highlights new adsorption unit. Components of liquid mixtures are selectively adsorbed. Wide industrial applications envisioned.

The door to continuous selective adsorption—for large-scale operations—may soon be opened.

The key? A two-step continuous operation: (1) selective adsorption of one or more components of a liquid mixture on an adsorbent belt followed by (2) desorption of sorbed components from the belt's pores.

▶ **Adsorbent Belt**—In Socony-Vacuum's new set-up, the liquid mixture to be treated flows—from the feed tank—onto an inclined, continuously-moving adsorbent belt. Liquid flows countercurrent to the belt; sorbable components are removed.

Unsorbed components pass through the belt, flowing down an inclined catch can into a trough. Some unsorbed material also flows down the surface of the belt, spilling over into the trough.

The belt (containing sorbed components) passes over guide rolls, then through pressure rolls. At this point, excess unsorbed liquid—adhering to the surface of the belt—is squeezed out, caught in a second trough and recycled to the feed tank.

▶ **Desorption** – The moving belt next passes over another set of guide rolls into a desorbing tank. Here a suitable elutriant removes sorbed components from the belt's pores.

Rolls, submerged beneath the tank liquid, guide the belt through the tank. Desorbed matter, floating on the surface of the elutriant, passes into a receiving tank.

▶ **Belt Revitalized**—On leaving the tank, the belt passes between pressure rolls which remove excess adhering elutriant. The latter drops into a trough, then returns to the desorbing tank.

Next, the belt passes between drying rolls (steam- or gas-heated) to remove residual elutriant and complete revitalization of the adsorbent.

Last step in the cycle: the belt passes over guide rolls, through drying rolls and finally through rolls which bring it in contact with the liquid feed again.

▶ **Pick Your Adsorbent**—Factors influencing the choice of adsorbent are: type of mixture undergoing treatment, pore size, ionic lattice and Van der Waal's forces.

Typical adsorbents include bauxite, silica gel, ion exchange resins, activated carbon, charcoal, etc. These materials are either impregnated on flat, flexible materials (e.g. textiles, paper, glass fabrics) to form continuous adsorption belts or sandwiched between two sheets of porous material.

▶ **Potential**—Continuous chromatographic adsorption is expected to find application in widely diverse fields, among them:

- Petroleum fractionation.
- Rare earth separation.
- Isotope concentration.
- Pharmaceutical purification.
- Lube oil decolorization.
- Water purification.
- Fatty acid fractionation.
- Cis-trans isomer resolution.
- Vitamin extraction.

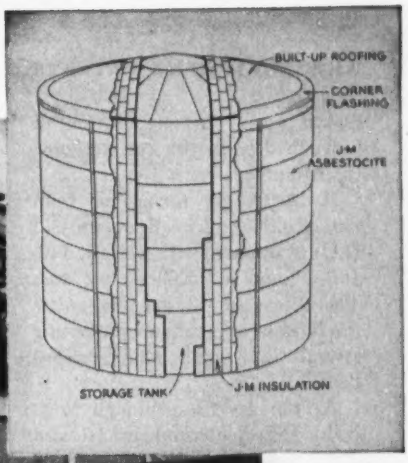
In any of these applications the sorbed fraction may be either a valuable component in the mixture or an impurity.—**U. S. 2,678,132 by Leslie C. Beard, Jr. to Socony-Vacuum Oil Co., Inc.**

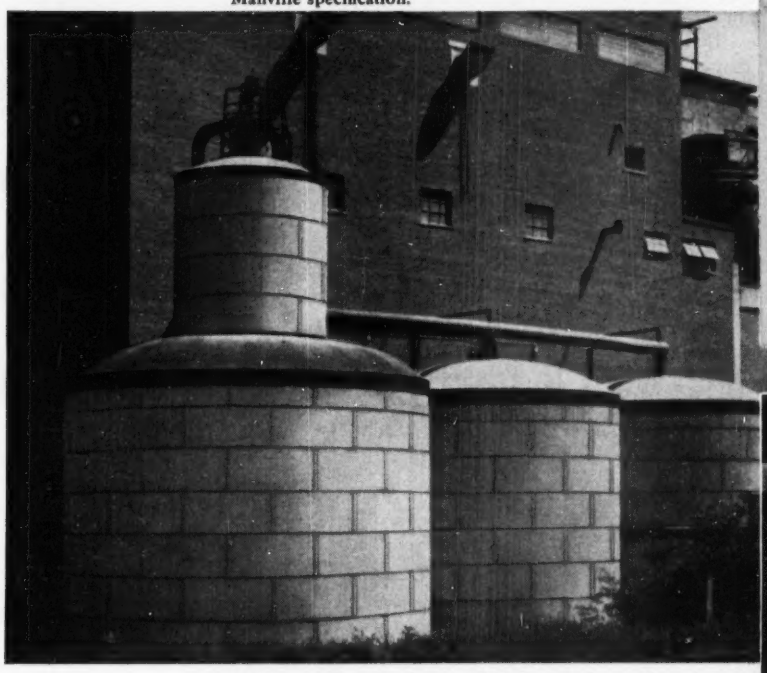
Isotopes Exchanged In the Vapor Phase

Vapor-phase exchange of isotopes is the claim of the Atomic Energy Commission's new reactor design.

▶ **Heavy Hydrogen**—By following a

Cutaway drawing shows how J-M *Weather-Protected* Insulation is applied to tanks such as those at the S. D. Warren Company paper mill. Standard methods for mechanical securement of the insulation are used. Asbestocite sheets are then applied over the insulation, in accordance with the simplified Johns-Manville specification.





▲ **(Above)** Completed job of J-M *Weather-Protected* Insulation on black liquor tanks of the S. D. Warren Company.

(Right) Skilled applicators of an outstanding J-M Insulation Contractor, P. S. Thorsen Co. of South Boston, Mass., applying Asbestocite sheets over Zerolite insulation.

S. D. Warren Company saves fuel, reduces maintenance on outdoor tanks with J-M *Weather-Protected* Insulation

On black liquor tanks of the S. D. Warren Company paper mill at Cumberland Mills, Maine, Johns-Manville *Weather-Protected* Insulation pays a "double dividend":

It saves money on fuel and maintenance. J-M Zerolite* insulation keeps the heat in . . . thereby saving a substantial amount in fuel costs. J-M Asbestocite*, a strong asbestos-cement sheet material, covers the Zerolite Insulation to protect it both from the weather and from wetting due to normal plant operations. This "bodyguard" layer of Asbestocite Weather Protection makes the tanks virtually maintenance-free and helps hold down operating costs.

It helps provide close temperature control. The temperature of black liquor in these tanks must be maintained so that it will flow freely and not clog up pumping apparatus. J-M Weather-Protected Insulation helps do the job dependably and economically.

Whatever the operating temperature of outdoor tanks and vessels, Johns-Manville offers the right insulation for application under the Asbestocite weather protection. For example, J-M 85% Magnesia Insulation is also widely used for this service because of its proved performance for temperatures to 600 F.

To be sure that the insulation and its weather protection is properly applied to pay the greatest return on your investment, J-M offers the services of experienced J-M Insulation Engineers and J-M Insulation Contractors. These men stand ready to give you an insulation job that will more than pay off your initial investment through maximum fuel savings.

For further information about J-M Weather-Protected Insulation, write to Johns-Manville, Box 60, New York 16, New York. In Canada, 199 Bay Street, Toronto 1, Ontario. *Reg. U. S. Pat. Off.

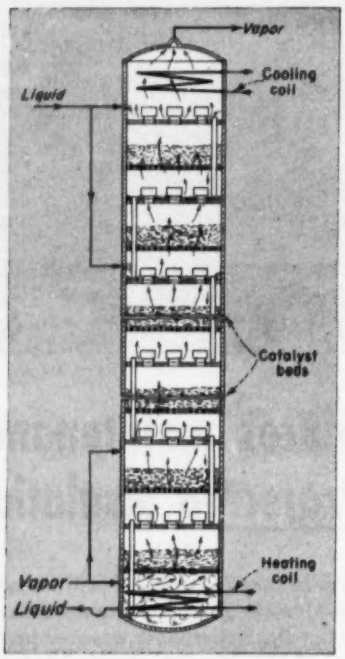
Johns-Manville *FIRST IN* INSULATION

MATERIALS • ENGINEERING • APPLICATION

typical process—the manufacture of heavy hydrogen—you can see how the equipment works.

Hydrogen gas (generated from water containing small amounts of D_2O) is saturated with water at 140-160 F. and atmospheric pressure. The water-saturated gas then enters the bottom of a column containing several horizontal solid catalyst beds.

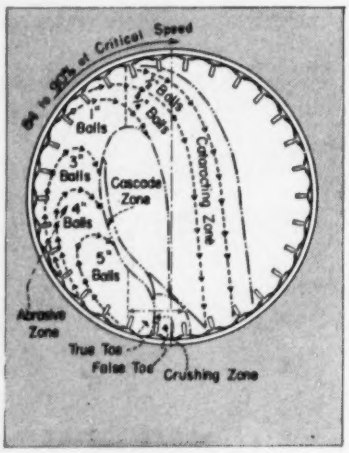
As the gas rises through these beds, free deuterium reacts with water vapor to form D_2O and release free hydrogen. Gaseous hydrogen exits from the tower top.



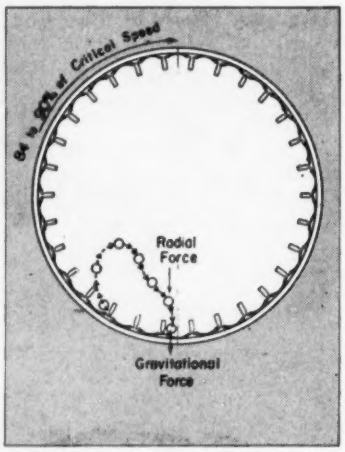
► **Water's Role**—Water, entering at the top of the column, serves a three-fold function: (1) periodically washes the gases after each catalyst stage, (2) keeps the water concentration of the gases at the saturation point—under prevailing tower conditions, (3) removes heavy water formed during the process, replacing it with ordinary water for further reaction.

As it descends through the tower, the water gradually is stripped of dissolved hydrogen and deuterium. Material exiting from the tower bottom is therefore substantially free of dissolved gases and has a higher concentration of D_2O than normally exists in ordinary water.

If the exiting liquid does not have a sufficiently high concentration of D_2O, it is returned to another hydrogen generator and then back to the reaction tower.—**U. S. 2,676,875 by Frank T. Barr to U. S. Atomic Energy Commission.**



SEASONED ball charge yields to . . .



UNIFORM ball charge in . . .

Novel Ball Mill Design

Greater crushing action, increased capacity, improved metallurgical results. These are three highlights of a new ball mill and charge.

Crusher bars—spaced around the interior drum wall—are the novel features of the new design. The mill charge consists of 5-in. balls (instead of balls of varying diameter) occupying no more than 3% of the total mill volume. Total mill charge is about 30% (as compared with the conventional 45 to 50%) of the mill volume—exclusive of voids. Rotational speed is about 85% of the critical speed.

► **Varying Ball Path**—As shown, if the conventional ball charge of varying sizes were used, the smaller balls would carry further than the larger ones. Balls of ½ to ¾-in. dia. would cataract or fall freely from a point near the top of the drum; larger balls (above 3 in.) would cascade. Near the upward moving side of the wall an abrasion zone (within the charge) would form.

► **Uniform Path**—In the new ball charge, all the balls follow the same general path. The charge acts as if the balls were strung together in a number of parallel chains lying along the length of the mill—each chain continuously rotating in the direction of the arrows.

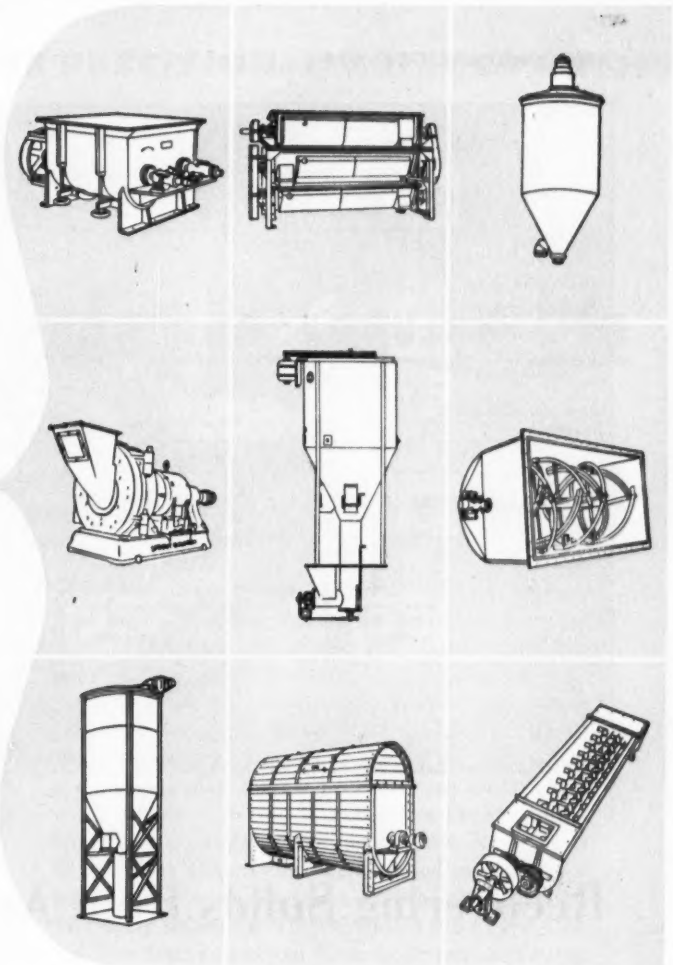
Because of the combined action of gravity and radial centrifugal force at the bottom of the mill, each ball entering the charge's toe has a high degree of inertia. As a crusher bar enters the "false toe" (created only when feed is supplied to the mill), it crushes material against the ball in the toe of the charge.

During periods when feed is not supplied to the mill (and there's no "false toe"), crushing action is due to the driving of balls—by the crusher bars—into the true toe.

Crushing action is similar to that of a jaw crusher. The crusher bar is the moving jaw; the ball, the stationary jaw.

By using large balls, the path is made as short as possible to accommodate more feed. Balls reduced to less than 3-in. dia. are removed from time to time.—**U. S. 2,680,568 by David Weston.**

what's most important to you in **MIXERS**?



FLOOR SPACE?
If limited space is your problem, Sprout-Waldron may have the answer. We have mixers so compact that one with 1250 cu. ft. capacity occupies only 90 sq. ft. of floor space.

POWER?
You can save power with Sprout-Waldron mixers—verticals in sizes up to 1500 cu. ft. operate with as little as 30 h. p.

CORROSION RESISTANCE—MATERIALS CONTAMINATION?
You can get a Sprout-Waldron made of wood, stainless steel, black iron, non-ferrous or commercial alloys engineered to meet your specific needs.

SELF-CLEANING?
Sprout-Waldron verticals are naturally self-cleaning, and horizontals can be made nearly so.

MIXING TIME?
Certain Sprout-Waldron models produce complete mixes in seconds after being charged with the last ingredient.

EASE OF CHARGING?
Some Sprout-Waldron mixers are self-contained—equipped with their own loading or charging means.

DISCHARGE EFFICIENCY?
Sprout-Waldron mixers can dump entire charge in one mass with properly designed discharge gates.

INTIMATE BLENDING?
With a Sprout-Waldron blender, particles can be made to lose their individual identities.

DUST AND PRESSURE TIGHTNESS?
All Sprout-Waldron models can be made dust-tight and pressure-tight.

TEMPERATURE CONTROL?
At Sprout-Waldron there is the know-how to incorporate heating, cooling and drying with mixing.

VISCOSITY PROVISIONS?
Sprout-Waldron equipment mixes dry and semi-dry materials, adds liquids to solids, and even mixes molasses in January.

Whatever your mixing requirements, Sprout-Waldron meets them with dependable guidance, unique *"adaptioneering"* methods, a complete line of equipment, and top-notch service. You get more at Sprout-Waldron, because Sprout-Waldron has more to give. Let us advise you on your next mixer installation without cost or obligation. *Please write for details.*

YOUR INVESTMENT PROTECTED
Our 88 years of service to industry is good assurance that you can obtain parts and service for the life of your Sprout-Waldron equipment.

SPROUT-WALDRON
Manufacturing Engineers Since 1866
Equipment for SIZE REDUCTION • MIXING & BLENDING • BULK MATERIALS HANDLING • PELLETING & CUBING • PRODUCT CLASSIFICATION
Facilities for fabricating, machining, custom founding, woodworking, laboratory testing
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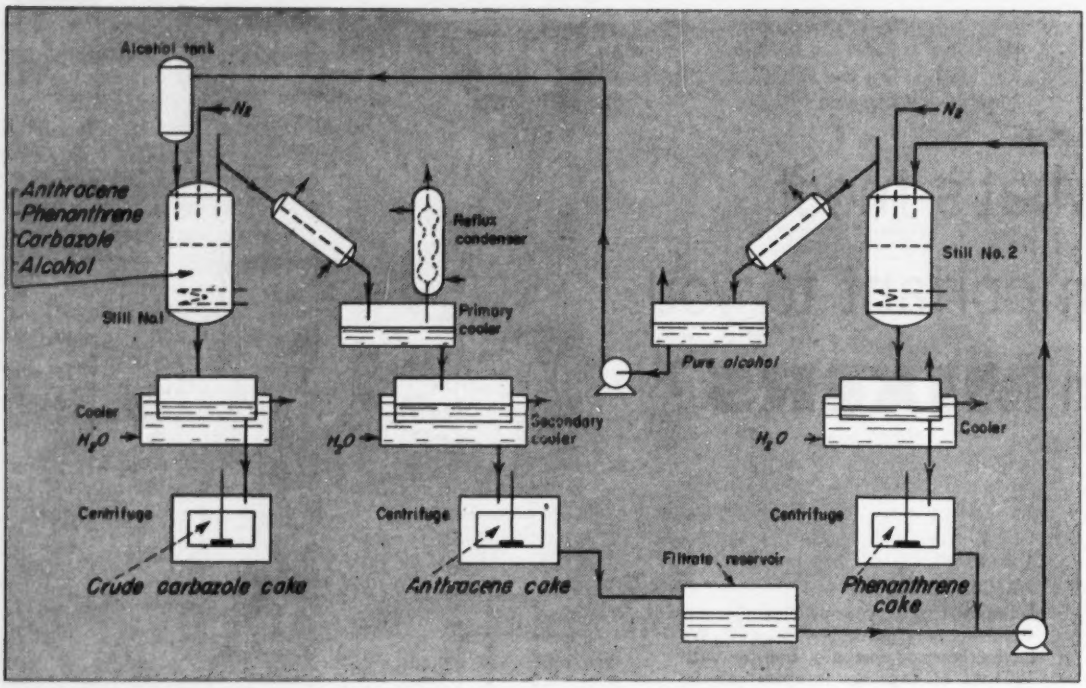


Recovering Solids from Anthracene Oil

Extraction with a high-boiling alcohol makes for easy separation of anthracene, phenanthrene and carbazole. Low-cost process yields pure products.

The conventional double headaches of high-cost and product impurity may disappear with U. S. Steel's new process for the recovery of anthracene oil's components. Here's how.

Solidified oil is treated with a high-boiling (360 to 450 F.) primary or secondary monohydric alcohol, having 6 to 12 carbon atoms. The selective solubility of the oil's three major components—anthracene, phenanthrene and carbazole—in the solvent, make separation possible in one continuous operation.

▶ **Alcohol Added** – Initially, semi-refined anthracene cake and alcohol feed into still #1—under a nitrogen atmosphere. After distillation starts, the nitgrogen supply is shut off.

More alcohol is added (by periodic or controlled continuous addition) to (1) provide a solvent medium and (2) maintain a weight ratio of alcohol to solute of less than one. Controlled heating keeps the alcohol solution at about 70 F. above the solvent's boiling point.

▶ **Anthracene**–Still vapors–an azeotropic mixture of alcohol, anthracene and phenanthrene–cool in a condenser, then go to a primary cooling chamber fitted with a reflux condenser.

Here the vapors cool to within 40 to 70 F. of the alcohol's boiling point. This temperature is above that at which anthracene crystallizes.

The condensed solution periodically feeds to a secondary cooler where it cools to room temperature. Because of phenanthrene's greater solubility in alcohol at this temperature, it remains in solution; anthracene crystallizes.

After thorough washing and drying (by centrifuging), anthracene is recovered as a 90 to 98% pure product.

▶ **Phenanthrene** – The phenanthrene solution flows to a filtrate reservoir from which it is periodically pumped into a second still. Aside from the solution inlet, this still has a nitrogen inlet (for air removal) and a vapor outlet hooked up to a condenser.

As the phenanthrene solution boils, part of the alcohol distills off, condenses and collects in a tank. From here it is periodically pumped back to the alcohol tank.

When the temperature of the solution in still #2 exceeds that of the vapor by 50 F., the residue

THESE EXCLUSIVE PRECISION-MACHINED GUIDES

eliminate chatter

lengthen service life

IN LUNKENHEIMER

IRON BODY GATE VALVES

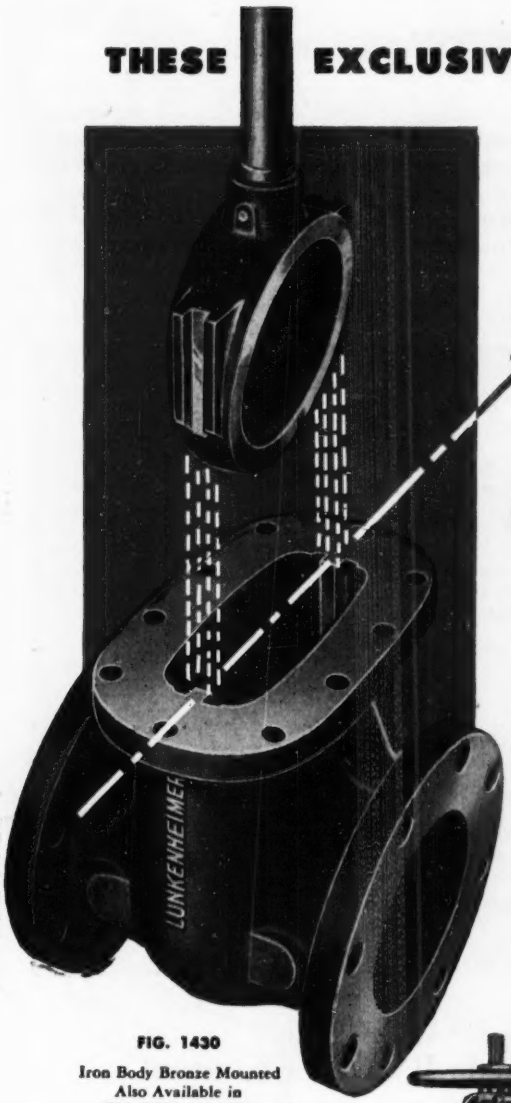
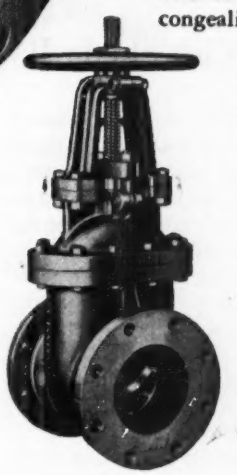


FIG. 1430

Iron Body Bronze Mounted
Also Available in
FIG. 1576 and 1578
All Iron
Screwed and Flanged Types
Fig. 1578N-4
3% Nickel Iron with
18-8 Mo (Type 316) Stainless Steel Trim

Gate valve chatter — the sound of wasteful, accelerated wear — is eliminated by Lunkenheimer's unique method of manufacturing Iron Body Gate Valves. Not only are the guide channels in the disc accurately machined, but the guides in the body as well. These precision-machined guides hold the disc firmly in line — prevent pressure from forcing the disc against the opposite seat. Result: no clatter, no chatter, and much longer valve life. The complete Lunkenheimer Iron Body Gate Valve line includes 3% Nickel Iron Gate Valves (Fig. 1578N-4) designed especially for mildly corrosive service in the oil, paper, and chemical processing industries. They have 18-8 Mo (Type 316) Stainless Steel and Monel Trim to protect the seating faces. All Lunkenheimer Iron Body Gate Valves feature solid discs without pockets that might trap congealing substances in the line. They also have handy swing-bolts and shelves that make repacking easy — are ideal for service in the chemical, petroleum, and pulp processing fields.



WRITE FOR Circular 564, describing the complete Lunkenheimer Iron Body Gate Valve line. Address: The Lunkenheimer Co., Box 360C, Cincinnati 14, Ohio, or phone your Lunkenheimer Distributor.

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QUALITY

IRON • STEEL • BRONZE

LUNKENHEIMER®

THE ONE *Great* NAME IN VALVES

L-253-98

drains to a cooler. Here it cools to room temperature—causing crystallization of phenanthrene.

Crystals, separated from the solution by centrifuging, are 80 to 90% pure. Filtrate is recycled to the second still.

▶ **Carbazole** – Distillation (in still #1) is discontinued when the carbazole concentration reaches 50%. The residue then drains to a cooler where it is sufficiently cooled to cause crystallization of crude carbazole.

Crystals are separted from the solution by centrifuging. Filtrate may be returned to the still or discarded.–**U. S. 2,675,345 by John W. Andrews to U. S. Steel Corp.**

Naphthalene Takes a Bath

Here's a switch in naphthalene refining borrowed from the housewife's domain. The new method is simple–and guaranteed to eliminate cumbersome, time-consuming, expensive operations. All you have to do is wash crude naphthalene crystals with a detergent.

▶ **Crystallizing The Crude** – First step in the process is the preparation of crude naphthalene crystals according to Gould's procedure. This involves washing molten crude naphthalene with sulfuric acid and crystallizing it from a hot caustic solution.

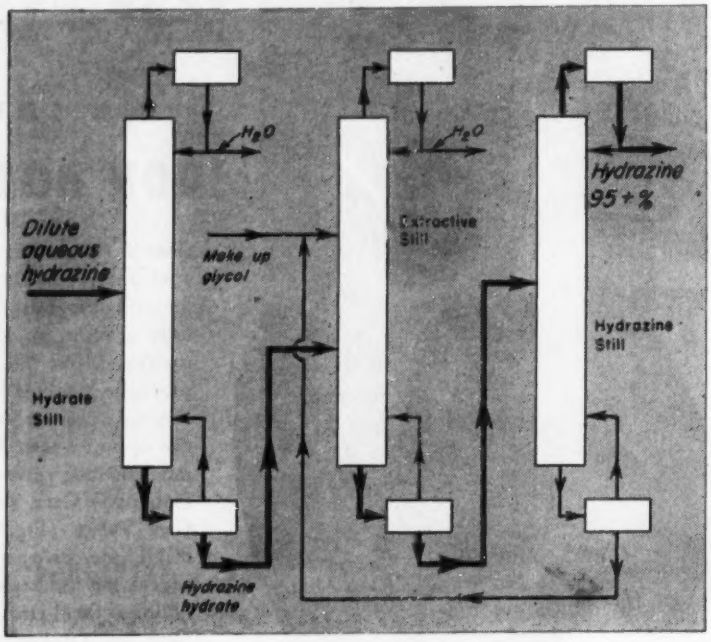
Crude solid thus obtained is heated above its melting point, then poured into cold water–to remove some of the oily impurities. Remaining impurities are removed by a hot detergent washing.

▶ **Pure Naphthalene**–Hot detergent solution (at 75 C.) is pumped from a jacketed tank, through spray nozzles, into a whizzer-type centrifuge containing the naphthalene crystals. After thorough washing and drying pure naphthalene, melting at 78 C. or higher, is removed.

The detergent must be a surface active agent which will not produce insoluble calcium salts. Anionics derived from high molecular weight organic sulfonates are preferred.–**U. S. 2,678,955 by Clinton B. Ogilvie to American Cyanamid Co.**

This department is a digest of recently issued patents, selected and evaluated for you by Dr. Melvin Nord, Chemical Engineer and Patent Attorney, 664 Putnam, Detroit 1, Mich.

You can get copies of any patents, including those mentioned here, for 25¢. Order by number from the Commissioner of Patents, Washington 25, D. C.



Hydrazine Sheds Its Water Content

Credit Mathieson Chemical Corp. with another first in handling a tough job. For Mathieson, a pioneer in the commercial production of hydrazine, has come up with a new hydrazine dehydrating process offering commercial possibilities. It hinges on the extractive distillation of hydrazine with a glycol.

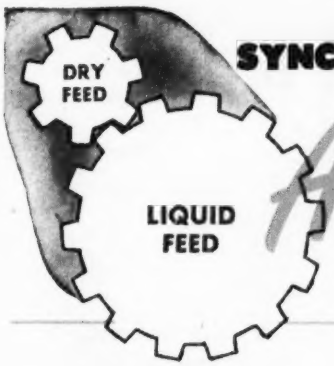
First step in the new method is the atmospheric distillation of very dilute hydrazine solutions to a final composition of at least 60% hydrazine.

▶ **Glycol Extraction**–Hydrazine hydrate then passes through a reboiler and enters a column where it is extracted with a glycol. Of the several glycols which will do the trick, ethylene glycol is preferred. The ratio of glycol to hydrazine hydrate –on a mole basis–is in the range of 1.25:1 to 4:1.

Water, overhead from the extractor, condenses. Part of it returns to the column; the rest is drawn off.

▶ **Anhydrous Hydrazine** – Column bottoms–consisting of glycol, hydrazine and less than 0.1 mole % water–pass through a reboiler, then enter a hydrazine still. The still is blanketed with an inert gas to prevent oxidation of overhead condensed product (95 + % hydrazine).

Still bottoms–glycol and 1 to 10% hydrazine–are recycled to the extractor.–**U. S. 2,678,298 by Bernard H. Nicolaisen to Mathieson Chemical Corp.**



SYNCHRONIZED

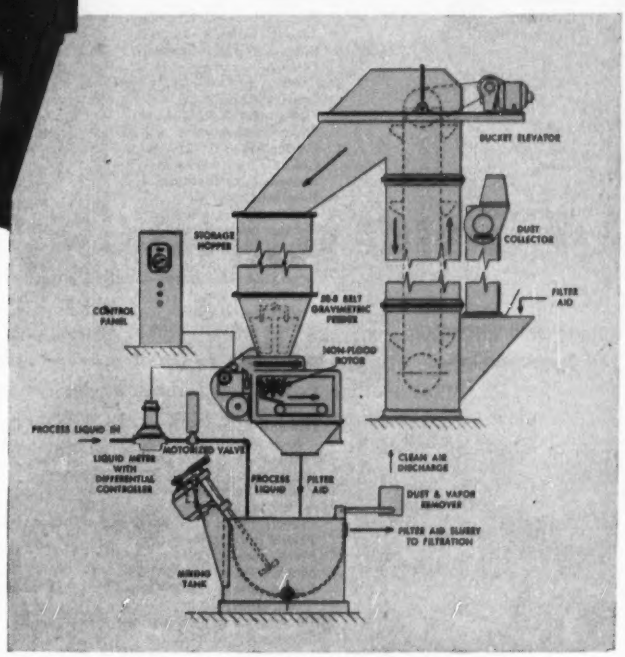
Automatic System

FOR **CONTINUOUS** PREPARATION OF FILTER AID SLURRY

Filtration — an increasingly important operation in the food, petroleum, pharmaceutical, and chemical industries — is put on a mechanized basis with this "packaged" system for preparing filter aid slurry . . . one of the many Omega Feeding and Proportioning Systems available to industry today.

This system feeds finely pulverized filter aid (weighing 7 to 15 lbs. per cu. ft.) in step with the flow of process liquid to the filters. A sensitive synchronizing unit maintains the pre-selected ratio of dry material to liquid . . . keeps slurry concentration at the optimum level . . . eliminates hit-or-miss, high-cost manual preparation. It's an Omega System throughout — from the Model 50-8 Belt Gravimetric Feeder (accurate within ± 1% by weight) to the mixing tank, dust and vapor removal devices, synchronizing mechanism, and control panel. The design and construction of this "packaged" system is 100% an Omega responsibility which relieves the customer of the purchasing and engineering of individual components.

Omega Dry and Liquid Feeders fit into the widest range of continuous processing and blending operations. Tell us about your problems and we will gladly submit recommendations and quotations. Omega Machine Company (Division of B-I-F Industries, Inc.), 369D Harris Ave., Providence 1, Rhode Island.



Continuous slurry preparation system including Omega 50-8 Belt Gravimetric Feeder with positive, non-flood feeding mechanism; mixing tank and agitators; dust collector, bucket elevator, storage hopper; control panel and differential controller.

OMEGA *THE LAST WORD IN* **FEEDERS**

DIVISION OF B-I-F INDUSTRIES, INC.

BUILDERS IRON FOUNDRY • PROPORTIONEERS, INC. • BUILDERS-PROVIDENCE, INC.

BIF METERS FEEDERS CONTROLS

Your Checklist of New Equipment Patents

Operation . . .	About . . .	Inventor or Assignee	Patent No ..
Adsorption	Apparatus for passing gas through a permeable adsorbent bed	Laurance S. Reid	2,678,108
	Fluidized adsorption process	Standard Oil Development Co.	2,678,111
Chemical reaction	Gas distributing and collecting channels for reaction vessels	Houdry Process Corp.	2,678,874
	Friedel-Crafts refortifying tower	Phillips Petroleum Co.	2,680,675
Crushing and grinding	Reduction mills	David Weston	2,678,167
	Fluid-swept ball mill with ball moving rotor and stationary drum	Rubye W. Phillips	2,678,168
	Impact hammer mill	David R. Tullis	2,678,169
Drying	Steam-heated dryer	The Pusey & Jones Corp.	2,677,898
	Adjustable scraper blade for dryers	Albert M. Fischer	2,678,093
Filtration	Continuous filter	Sun Oil Co.	2,678,133
	Filter indicator	Caterpillar Tractor Co.	2,678,134
	Filtering apparatus	The Commonwealth Engineering Co. of Ohio	2,679,936
Fluid and particle flow	Pipeline transportation of natural gas	The Chemical Foundation, Inc.	2,677,945
	Automatic control system for drum handling	T. W. Snow Construction Co., Inc.	2,678,240
Heat transfer	Seal for regenerative heat exchangers	Power Jets (Research & Development) Ltd.	2,678,193
	Seal for rotary heat exchangers	Jarvis C. Marble et al.	2,678,194
	Pebble heater	Phillips Petroleum Co.	2,678,812
	Pellet cells in rotary regenerative heat exchanger	The Air Preheater Corp.	2,680,008
	Mechanical draft cooling tower	Foster Wheeler Corp.	2,680,603
Screening	Bar screen with motion-imparting members	Productive Equipment Corp.	2,679,318
Solid-gas separation	Self-cleaning air filter	Pangborn Corp.	2,678,109
	Cyclone separator	Walter M. Madsen	2,678,110
Solid-liquid separation	Flocculation and sedimentation	The Dorr Co.	2,678,730
	Precipitator	Societe d'Electro-Chimie	2,678,873
Solid-solid separation	Air float concentrator	Robert F. Dore	2,678,131
	Raking classifier	The Dorr Co.	2,678,721
	Suspension separation of solids	Societe Jarusa A. G. Chur	2,678,727
Storage	Vacuum-insulated container for liquefied gases	Union Carbide and Carbon Corp.	2,677,938
	Liquefied gas container	Henry H. Clute	2,677,939

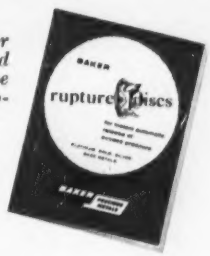
. . . And New Process Patents

Product . .	Process	Inventor or Assignee	Patent No . .
Catalysts	Manufacture of silica-magnesia catalyst	The Davison Chemical Corp.	2,680,100
Fats and oils	Alkali-refining in the presence of a tartaric cpd.	Lever Brothers Co.	2,678,325
	Refining oils with polycarboxylic acids	Lever Brothers Co.	2,678,326
	Treating crude glyceride oil	Benjamin Clayton	2,678,327
	Refining vegetable and animal oils	Aktiebolaget Separator	2,678,936
	Destearinization of glyceride oils	The Pure Oil Co.	2,678,937
	Stabilization of fats for soap	Swift & Co.	2,680,122
	Solvent extraction of oils, fats, waxes from solids	Tiger Oats & National Milling Co., Ltd.	2,680,754
Fertilizers	Production of fertilizers	Allied Chemical & Dye Corp.	2,680,679–80
Gases	Chlorine from oxidized HCl	Diamond Alkali Co.	2,678,259
	Acetylene production	Union Oil Co. of Calif.	2,679,540–4
	Rectification of air	Arthur D. Little, Inc.	2,680,357
Hydrocarbons	Olefin polymerization	Standard Oil Development Co.	2,678,904
	Polymerization of olefins	Socony-Vacuum Oil Co., Inc.	2,678,957
	Separation of aliphatic hydrocarbons by azeotropic distillation	Phillips Petroleum Co.	2,679,472
	Separation of eutectic-forming hydrocarbons by crystallization	Phillips Petroleum Co.	2,679,539
	Preheating oil shale	Standard Oil Development Co.	2,680,091
Inorganic chemicals	Sulfuric acid production	Guiseppe Busetti et al.	2,678,872
	Preparation of anhydrous hydrazine	Mathieson Chemical Corp.	2,680,672–3
Organic chemicals	Olefin esterification using ion exchange resin catalysts	Standard Oil Development Co.	2,678,332
	Catalytic isomerization of methyl-substituted phenols	Shell Development Co.	2,678,337
	Extractive distillation purifies aqueous formaldehyde solutions	Celanese Corp. of America	2,678,905
	Preparation of nitramines	Honorary Advisory Council for Scientific and Industrial Research	2,678,927
	Preparation of alkali metal xanthates	B. F. Goodrich Co.	2,678,939
	Alkylation of phenols	Shell Development Co.	2,678,951
	Preparation of fluorinated organic bromides	Douglas Aircraft Co., Inc.	2,678,953
	Phenol purification	California Research Corp.	2,679,535
	Photochemical production of chloral	Mathieson Chemical Corp.	2,680,092
	Making organic isocyanates	Monsanto Chemical Co.	2,680,127–30
	Preparation of tertiary butyl-isopropylbenzene hydroperoxide	Phillips Petroleum Co.	2,680,138
	Preparation of hydroperoxides	Societe des Usines Chimiques Rhone-Poulenc	2,680,139
	Glycerine production	Glycerine Corp. of America	2,680,703
	Preparation of fermentation glycerine	Backhefe G. m b. H.	2,680,704
Pharmaceuticals	Penicillin production	Corn Products Refining Co.	2,678,903
Resins	Production of polymerized polyester resins containing an amine aldehyde-treated filler	Allied Chemical & Dye Corp.	2,680,104
Rubber	Synthetic rubber emulsion polymerizations	U. S. Rubber Co.	2,680,111
Synthesis gas and products	Aviation gasoline production	Gulf Research & Development Co.	2,678,263
	Synthesis gas production	Standard Oil Development Co.	2,678,264
	Reduction of sulfur content of oxo alcohols	Standard Oil Development Co.	2,678,952
	Catalytic hydrogenation of CO	Metallgesellschaft A. G.	2,680,125
	Means of hydrogenating CO	The Texas Co.	2,680,126
Vitamins	Vitamin B_{12} extraction	Merck & Co., Inc.	2,678,900

Precious Metal Rupture Discs

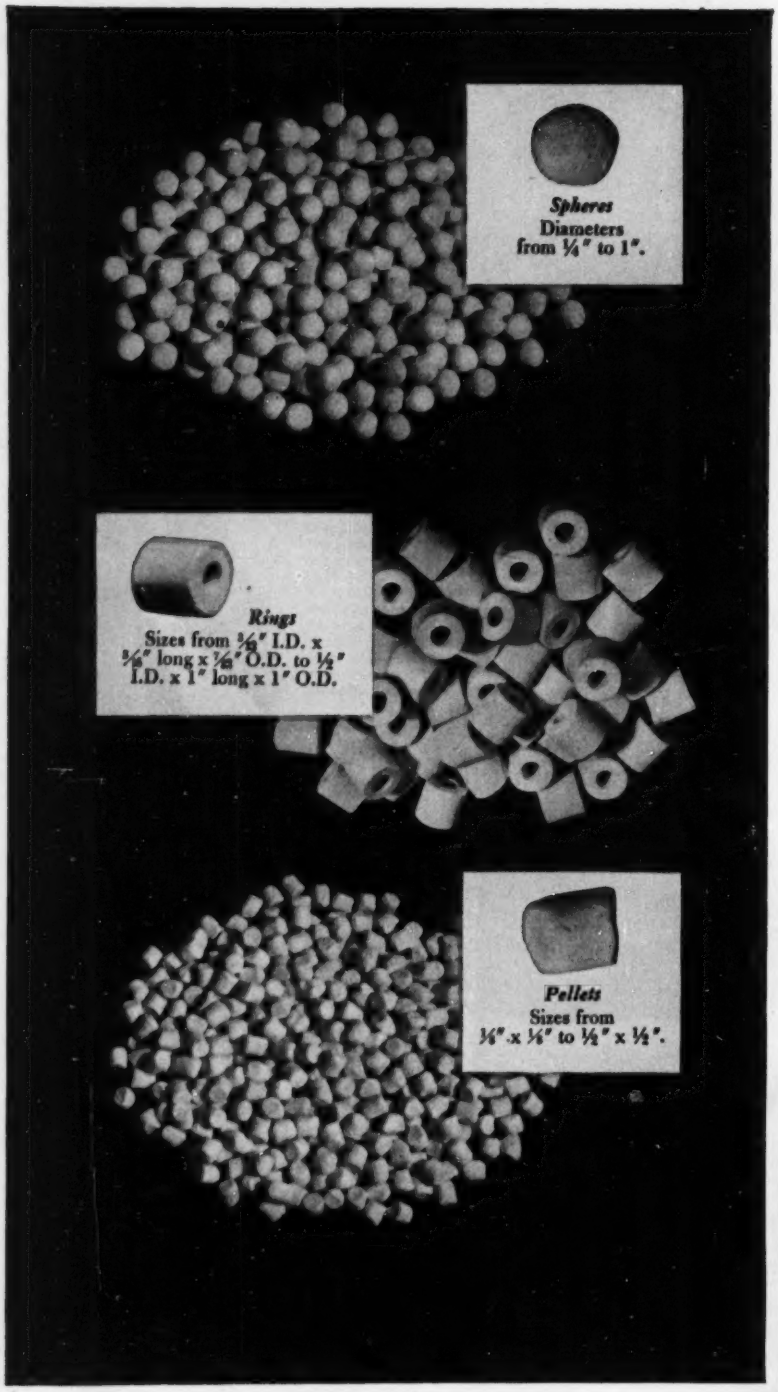
If the liquids or gases you deal with in your pressure equipment are in the slightest degree corrosive, only corrosion-resistant precious metal rupture discs will provide absolutely dependable protection against excess pressure. Where discs of base metal alloys, even stainless steel, are attacked and rendered dangerously inaccurate by corrosion, precious metal discs will maintain their accuracy intact. Baker Precious Metal Rupture Discs are precision-made to your specifications for pressures from a few pounds to several thousand pounds. The precious metal is recoverable, with high resale value, so that the additional final "use" cost of this dependable protection is negligible.

Send for the free booklet, "Baker Rupture Discs." Information and data to help you select the type of disc that will give you absolute protection.



BAKER & COMPANY, INC. PRECIOUS METALS

113 ASTOR STREET, NEWARK 5, NEW JERSEY • NEW YORK SAN FRANCISCO CHICAGO LOS ANGELES

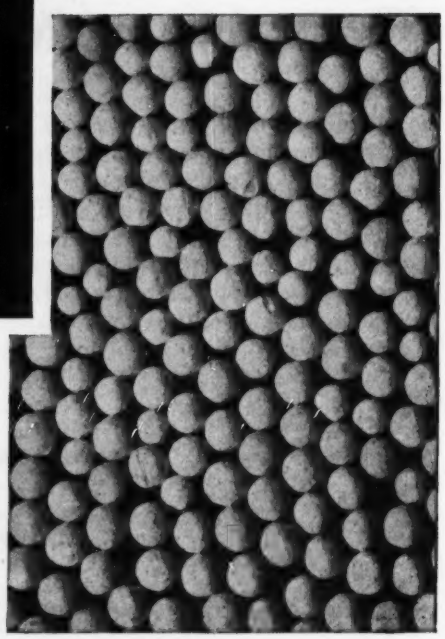


Rx for

Norton catalyst carriers — spheres, pellets and rings — are commercially available in ALUNDUM*, (fused alpha alumina) mixtures. Experimental quantities are available in MAGNORITE*, FUSED STABILIZED ZIRCONIA, CRYSTOLON* and MULLITE.

Norton spherical carriers provide uniform beds in catalytic converters, reducing channeling and pressure drop to a minimum. Medium porosity spheres have porosity ranging from 40% to 44% with a network of open pores on the outside surface only. These are suitable for applications where the carrier is coated with a catalyst. High porosity spheres have porosity ranging from 45% to 49%, with a network of open pores on the outside surface as well as throughout the entire sphere. These are suitable for applications where the carrier is impregnated with a catalyst.

Norton ALUNDUM carriers are proving highly successful in reaction such as those involved in the manufacture of phthalic anhydride, maleic anhydride and oxidation of ethylene. Containing 77% to 89% alumina, they are outstanding for chemical stability and resistance to abrasion and erosion. Write for Bulletin #7, containing additional data on ALUNDUM catalyst carriers.



Norton heat exchange pebbles are made of ALUNDUM.* Because of their high alumina content (over 95%) they are ideally suited for pebble type heaters, where they are important as the heat-transfer medium, whether oxidizing or reducing conditions are encountered.

Their ability to withstand abrasion, impact and repeated heating and cooling makes them ideal for heat exchange beds of either the static or moving type. Their high refractoriness prevents softening or incipient fusion at any point in the upper bed. This keeps them from "bridging" together and causing stoppages in a moving bed. ALUNDUM heat exchange pebbles are available in ¼, 5/16, ⅜ and ½" diameters.

higher production... better processing...lower costs

Norton refractories are engineered for top performance — and prescribed for many chemical applications

For your refractory uses, Norton refractory products are *engineered and prescribed* to give you the best possible ℞ — the most effective combination of physical characteristics plus thermal, chemical and electrical properties.

The ℞'s you need to improve and economize your processing are ready for you in this complete, top-quality line. For details, including expert technical aid, call in your Norton Refractories Engineer. Meanwhile, write for the fact-filled bulletins, mentioned in this advertisement, that cover your particular requirements for dependable, money-saving refractories. NORTON COMPANY, 504 New Bond Street, Worcester 6, Mass. *Canadian Representative:* A. P. Green Fire Brick Co., Ltd., Toronto, Canada.

NORTON

REFRACTORIES

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Making better products... to make other products better

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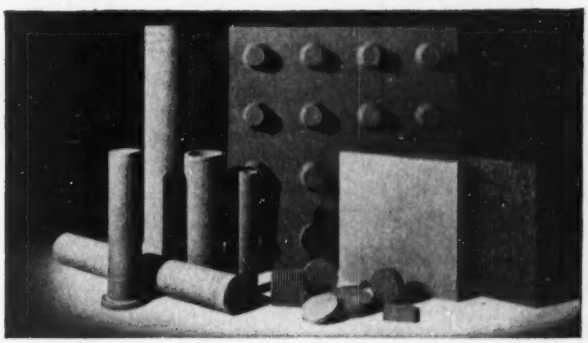
Norton electric furnace shapes and laboratory ware

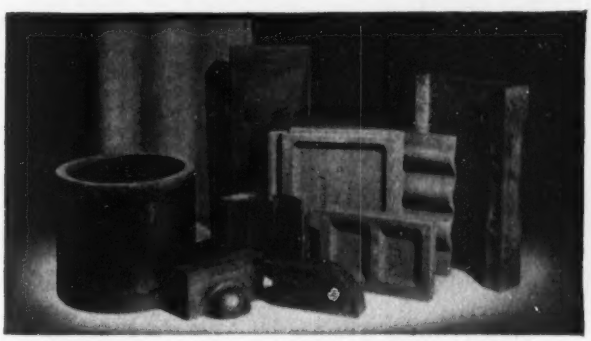
Norton electric furnace refractories — cores, tubes and muffles — are made of ALUNDUM or CRYSTOLON materials. ALUNDUM shapes, composed of 99% pure fused alumina, are characterized by great stability, chemical inertness, excellent thermal conductivity and good electrical insulation qualities. CRYSTOLON shapes, for use under more limited conditions, combine high thermal conductivity with resistance to heat shock. Bulletin No. 458 tells how to construct electrical furnaces for the laboratory.

Norton ALUNDUM laboratory ware, available at your laboratory supply house, offers many properties important to development, experimental or analytical work. It is chemically stable, stands temperatures up to 1900°C and is easy to clean. For filtering, it comes in four degrees of permeability. Bulletin No. 793 gives you the whole story.



Norton porous mediums come in plates, tubes, discs and diaphragms, engineered to fit your filtering, diffusing or aerating requirements. All have uniform porosity, in the size and open-pore ratio you need. Made of ALUNDUM material that is chemically stable and strong. Thus, their resistance both to acid and alkaline conditions gives them extra long life. Norton seamless porous tubes have the advantage, unusual in tubes, of uniform porosity over their entire area — permitting constant air or liquid pressure and enabling uniform backwashing to do more thorough cleaning.

Typical applications are filtering water or solvents; cutting oils, wine and other liquids; reclaiming cleaning fluids; handling industrial oil wastes. Bulletin No. 140 tells you more about Norton ALUNDUM porous mediums.



Norton refractory shapes for reaction furnaces come in bricks, plates, tubes and blocks, made of ALUNDUM, CRYSTOLON, MAGNORITE and FUSED STABILIZED ZIRCONIA refractory materials. The development of FUSED STABILIZED ZIRCONIA is a typical example of how Norton aids you in utilizing higher temperatures for greater efficiency and output. Norton was the first to bring this valuable material out of the experimental stage into commercial production. Now it is used in many processes.

No other refractory is so chemically stable at such high temperatures under both oxidizing and reducing conditions. In gas synthetic processes, furnaces lined with it have withstood temperatures approaching 4700°F for long periods. Its low thermal conductivity (6.2 BTU in dense shapes at 2000°F) and its high electrical conductivity at high heat are other important properties, all of which are described in Bulletin No. 1409.

YOU SPECIFY . . .

Shafts
1. General-purpose.
2. Extra-rigid.
3. Two-piece.
4. Two-piece, extra-rigid.

Bearings
1. Pre-packed, single-row, double-width.
2. Replenishable grease-lubricated.
3. Oil-lubricated, single-row.
4. Oil- or grease-lubricated, double-row

Seals
1. Packed stuffing box, internal liquid seal.
2. Packed stuffing box, with internal seal blocked for external lubricating, sealing or flushing.
3. Jacketed stuffing box for controlled temperature.
4. Internal mechanical seal, lubricated and cooled.
5. External mechanical seal, lubricated and cooled.

Impellers
1. Semi-open.
2. Closed.

Materials
1. Ampco alloys (aluminum bronzes).
2. Nickel-chromium alloys.
3. Illium G.
4. Hastelloys.
5. Nickel.
6. Nickel-copper.
7. Stainless steels.

Capacity
Up to 600 gpm.

Head
Up to 140 ft.

YOU GET . . .

"Off-the-Shelf" Pumps With "Custom-Built" Features

Late in August initial customer orders will be accepted on a new line of stock centrifugal pumps that offers some noteworthy features:

- Stocked in aluminum bronze or nickel chrome.
- Has wide interchangeability of parts.
- Built in five sizes to 140 ft., 600 gpm.
- Will withstand erosive, corrosive conditions.

Until now pumps constructed of aluminum bronze could be obtained from pump makers only on special order. Price was high and delivery slow.

Now for the first time they will be available as stock items, competitively priced. Initially, they will be built in five sizes from 1½x1½ to 4x3 with other sizes to be added later.

▶ **Tough and Able**—Ampco (aluminum bronze) alloys used in construction of the pumps are noted for resistance to erosion, corrosion (*Chemical Engineering*, Jan. 1951, p. 108) and cavitation-pitting. Together with excellent hydraulic design this trait provides attention-free pumping of many liquids normally considered difficult to handle, including those having abrasive solids in suspension.

▶ **Adaptable**—A unique feature of the entire line is the ready interchangeability of parts. As a starter you can select from available stock components (see list at left) exactly the combination to satisfy your needs.

But that's not all. If process conditions change the pump can be altered in the field to satisfy the new requirements. This is more economical than complete replacement of the pump.

As an example, say the pump has been operating with an internal-seal stuffing box where the pumped liquid contacts the seal. Because of a change in process conditions you must change to an external seal and cool it.

All you do is remove the flange, rotate it 180° and replace. The internal hole now is blocked off. Product will not be contaminated.

Or take the case of a pump moving liquid so extremely corrosive that it attacks any chosen alloy. Here a two-piece shaft facilitates removing and replacing the corroded impeller without disturbing either bearings or piping.

To protect against corrosion, aluminum bronze construction is used also in the supporting members of the pump. Where corrosive atmosphere exists this provides added protection.

▶ **Mechanical Highlights**—Another important feature is multi-seal protection of bearings. Between the stuffing box and bearings there is a labyrinth slinger seal, and an O-ring seal to stop liquid creeping along the shaft, then finally an oil or grease seal.

The popular, replenishable, grease-lubricated bearing arrangement has been improved so that used and surplus grease is carried away from the bearing when fresh lubricant is being supplied. Danger of overgreasing is eliminated by this feature.

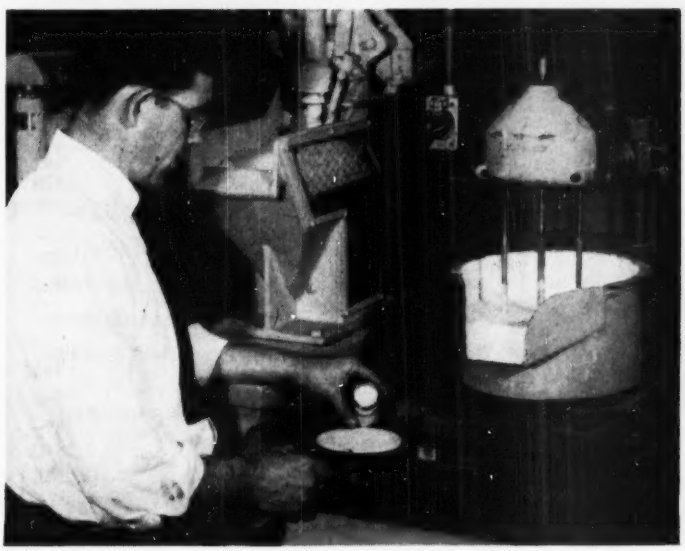
Design of the pump casings has eliminated blind tapping of bolt holes. Gaskets are confined within joints under uniform and resilient

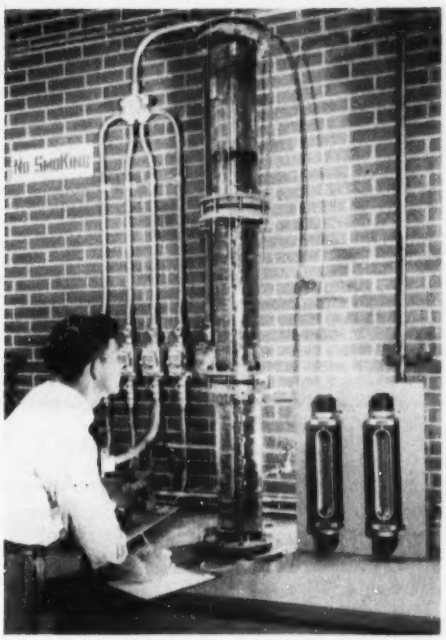
Turbo-Mixing

TURBO-MIXER GENERAL AMERICAN TRADE MARK

TURBO-MIXER, a division of

GENERAL AMERICAN TRANSPORTATION CORPORATION





In most businesses a testing laboratory is a basic need. For designing and building mixers, the Turbo-Mixer Division has operated a fully equipped lab for many years. Here, a trained and experienced staff does all the testing necessary to obtain the data necessary for solving mixing problems.

However, practical solutions to mixing problems come from a much wider background: training and experience in mixing for every industry—dating back to 1913.

Make use of this experience gained in designing actual working installations as well as complete and thorough laboratory tests. Write for help in evaluating your mixing problems.

"practical" solutions to mixing problems start in our laboratory

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OTHER GENERAL AMERICAN EQUIPMENT:—DRYERS • DEWATERERS TOWERS • TANKS • PRESSURE VESSELS

Equipment on these pages this month made news . . .

Page Number is also Reader Service Code Number

New Fluids Handling Equipment
- Centrifugal Pumps 268A
- Dry Plug Valves 270A
- Tapered Plug Valves 270B
- Dust Filter 272A
- Pipes and Ducts 272B
- Exhaust Fans 272C
- Dust Collector 272D

New Maintenance Tools & Supplies
- Percussion Lance 274A
- Drum Cleaner 274B
- Floor Patching Compound 274C

New Materials of Construction
- Porcelain-Lined Pipe 276A
- Industrial Flooring 276B
- Structural Steel Fastenings 276C
- Pipe Insulation 276D
- Stainless Steel 276E
- O-Rings 276F

New Heating & Cooling Equipment
- Process Burner 278A
- Dowtherm Vaporizer 278B
- Power Exhauster 278C
- Heating Mantle 278D
- Immersion Heater 278E
- Immersion Heater 278F

New Safety Equipment
- Shoe Covers 280A
- Fire Hood 280B
- Fire Blanket 280C
- Hand Truck Guard 280D
- Portable Fire Pump 280E
- Electric Warning Light 280F

New Packaging & Handling Equipment
- Bulk Conveyor 282A
- Drum Rack 282B
- Belt Conveyors 282C
- Storage Bins 282D
- Fork Trucks 282E
- Tractor Shovel 282F

New Processing Equipment
- Pressure Closure 284A
- Vacuum Filter 284B
- Hydraulic Classifier 284C
- Portable Spray Dryer 284D
- Ion Exchange Water Diffuser 284E

. . . For more details, use Reader Service Card on page 465

load, regardless of changing temperature. There is said to be similar built-in compensation for shaft seals.

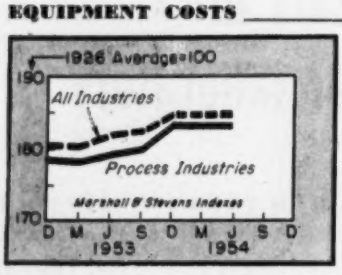
All in all Ampco people feel their pump offers maximum standardization and flexibility—can be used in place of regular pumps now in use.—**Ampco Metal, Inc., Milwaukee 46, Wis.** 268A

Fluids Handling Briefs

Dry plug valves from stock now have Hycar-coated plug. Recommended for wide range of services. Operates between −40 and +200 F. Available as either wrench, handwheel or gear-operated.—**Wedgeplug Valve Co., Inc., New Orleans, La.** 270A

Tapered plug valve is free of seizing from −65 to +250 F and pressures up to 100 psi. Reason: plug is Teflon, does not need lubricant. Angle 2, 3, and 4-way types with or without drain, aluminum alloy or stainless steel body.—**Republic Mfg. Co., 1930 West 77th St., Cleveland 2, Ohio.** 270B

EQUIPMENT COSTS



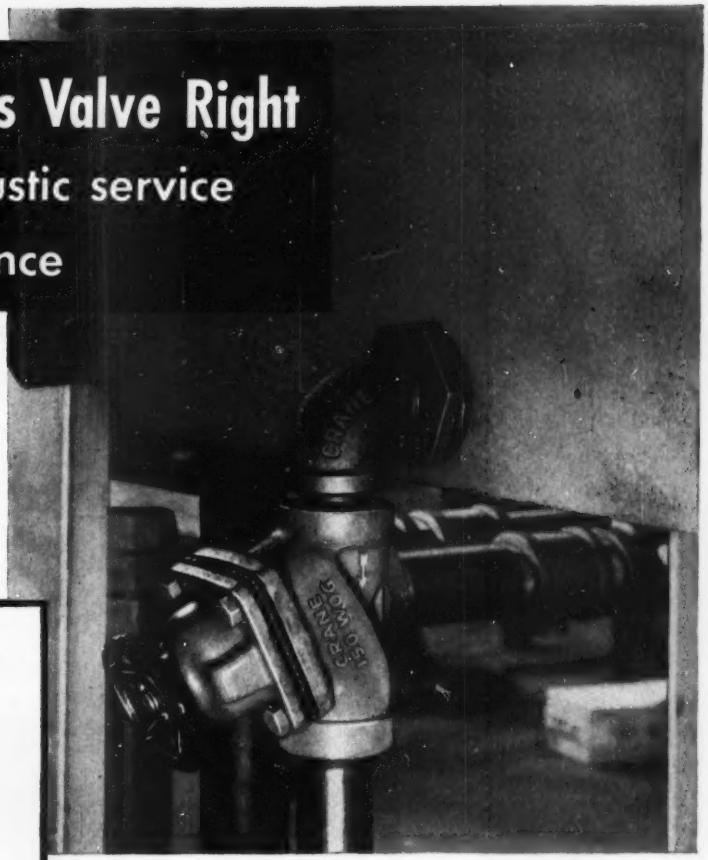
Process Industries	Mar. 1954	June 1954
Cement mfg.	177.8	178.0
Chemical	186.4	186.6
Clay products	172.6	172.8
Glass. mfg.	176.2	176.4
Paint mfg.	179.5	179.7
Paper mfg.	179.8	180.0
Petroleum ind.	183.0	183.2
Rubber ind.	185.4	185.6
Process ind. avg.	183.5	183.7

Related Industries		
Elec. power equip.	188.3	188.5
Mining, milling	187.4	187.6
Refrigerating	205.1	205.3
Steam power	175.7	175.9

Compiled quarterly by Marshall and Stevens, evaluation engineers, Chicago and Los Angeles. See *Chem. Eng.*, Nov. 1947, pp. 124-6 for method of obtaining index numbers; March 1954, pp 214-5 for annual averages since 1913.

3 Years Prove This Valve Right

for this gritty caustic service for instance



The Installation

On Trucleen dry cleaning machine, product of the American Laundry Machinery Co., Cincinnati, using Crane Diaphragm Valves as standard specification on 100° F. strong soap solution drain lines.

Valve Service Ratings

SUITABILITY: Outperforms all valves tried

FEATURES: Sealed-to-fluid bonnet

MAINTENANCE COST: None

SERVICE LIFE: No replacements since adopted 3 years ago

OPERATING RESULTS: Better machine operation—more satisfied users

PRICE: No premium

AVAILABILITY: Catalog item—No. 1610

The Valve

The diaphragm in Crane packless valves does one job only—sealing the bonnet. Independent disc does the seating—saves wear and tear on the diaphragm—permits closure of the valve even should diaphragm fail. Choose these valves from wide variety of body and trim materials—including linings—for corrosive, erosive, and ordinary services. Full information in new booklet; ask your Crane Representative for a copy.

The Case History

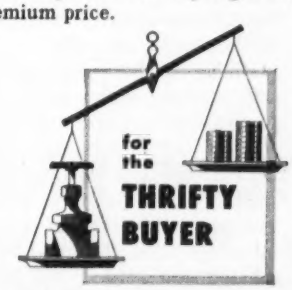
Conventional valves were previously used. Not until Crane Diaphragm Valves were tried was their designed-in superiority for this service fully realized. Working parts of the formerly used valves were constantly exposed to the effects of the gritty sediment solution. Seats, stem, even packing were subject to accelerated wear. The soapy solution would settle and build up in the bonnet.

Not so with No. 1610 Crane Diaphragm Valves. Their bonnet and working parts are completely sealed to line fluid. Their pliable Neoprene disc insert absorbs and seats tightly on foreign matter that quickly damages conventional valves.

Standard equipment on Trucleen machines now for more than three years, Crane Diaphragm Valves show this record: not one bit of trouble . . . no leaks . . . no repairs . . . they're absolutely right for the job—at a no-premium price.

THE BETTER QUALITY . . . BIGGER VALUE LINE . . . IN BRASS, STEEL, IRON

CRANE VALVES



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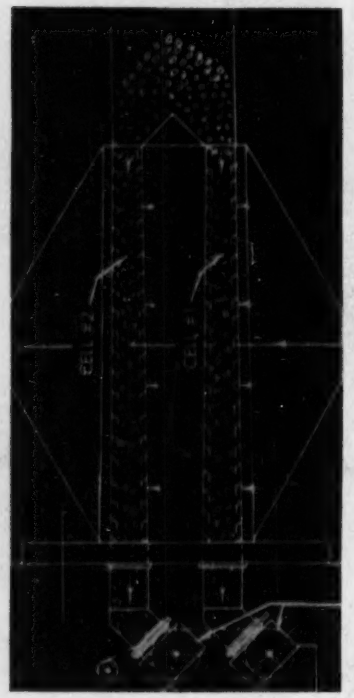
Branches and Wholesalers Serving All Industrial Areas

VALVES • FITTINGS • PIPE • PLUMBING • HEATING



Dust Filter

Passes gas through moving bed of solid granules.

Fumes, dust and smoke are removed from air or gas by a bed of moving granules in the Impingo filter. These units are recommended for controlling fumes and smoke in coke quenching, drying and other operations where high temperature or corrosive conditions are present.

In the Impingo filter, gases are passed horizontally through two or more cells containing moving granules. Solids in the gases strike the granules and adhere, so that exhaust gas is free of suspended matter. Dirty granules move downward, passing out of the cells then through a washing circuit, and back to the top of the cells.

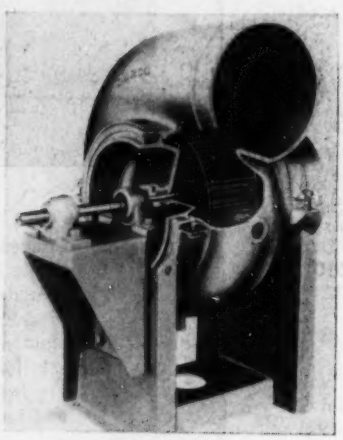
Filters can have any number of cells arranged either for series or parallel flow. A series of cells can contain more than one size or kind of granule, each to serve a specific purpose—such as moisture absorption, dust removal or chemical composition change.—**Mechanical Industries, Inc., 933 Grogan Bldg., Pittsburgh 22, Pa.** 272A

Pipes and Ducts

Corrosion resistant of polyester-bonded fibrous glass.

Dense, homogeneous nature of DuVerre #11 resin-bonded fibrous-glass pipes, ducts and fittings makes delamination almost impossible. An exclusive method of laying up the layers of glass mat in random directions produces homogeneity.

Vent pipe is installed readily with standard connections; because of strength and lightness requires few hangers. Dimensional uniformity permits installation with speed and ease, reduces labor time and cost.—**DuVerre, Inc., P. O. Box 97, Hamburg, N. Y.** 272B



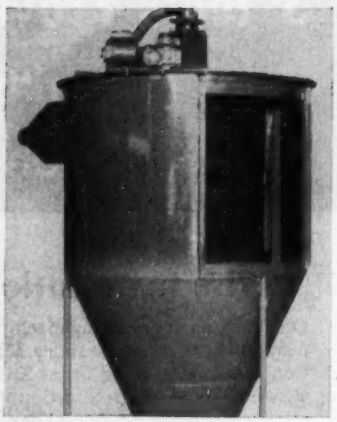
Exhaust Fans

Offer light weight and resistance to corrosion.

Constructed entirely of metal The Durco B series of exhaust fans is built to resist corrosive fumes and gases. Fans are claimed more efficient and less expensive than previous units.

Fan casing is Duriron; rotor is a multi-blade, forward curved element of Durimet 20, a high nickel stainless steel. New design and construction features make these fans 40 percent lighter in weight.

Series B fans are available with capacities up to 8,000 cfm.—**The Duriron Co., Inc., Dayton 1, Ohio.** 272C



Dust Collector

Based on reverse jet, incorporates new principles to gain efficiency.

High efficiency is claimed for a new type of reverse-air-jet dust collector. Design allows unit to handle extra-heavy dust loads without overloading. Now also, dust can be collected economically in pneumatic conveying systems operating under high-pressure conditions.

Collector is built with large cylindrical perforated-metal cage enclosed within a cylindrical housing. Filter medium is supported on the exterior surface of the cage. Dust and dirt are filtered out of the air as it passes inward through the cylindrical filtration element.

Filter medium is cleaned by a vertical blow tube that rotates continuously around between the perforated metal cylinder and the filter medium. Blow tube extends the full height of the cylinder and has a narrow slot running the entire length. Outside the fabric is a matching slotted receiver tube that is synchronized to move with the blow tube.

Accumulated dirt on the filter is blown into the receiver tube by the high pressure air from the blow tube. Then it drops into a hopper for either continuous or intermittent removal.

Model R Aeroturn operates in the range from 300 to 10,000 cfm. —**Turner & Haws Engineering Co., Inc., 67 Gardner St., Boston, Mass.** 272D

DC SIGNAL TRANSMISSION

...a vital contribution to complete automation

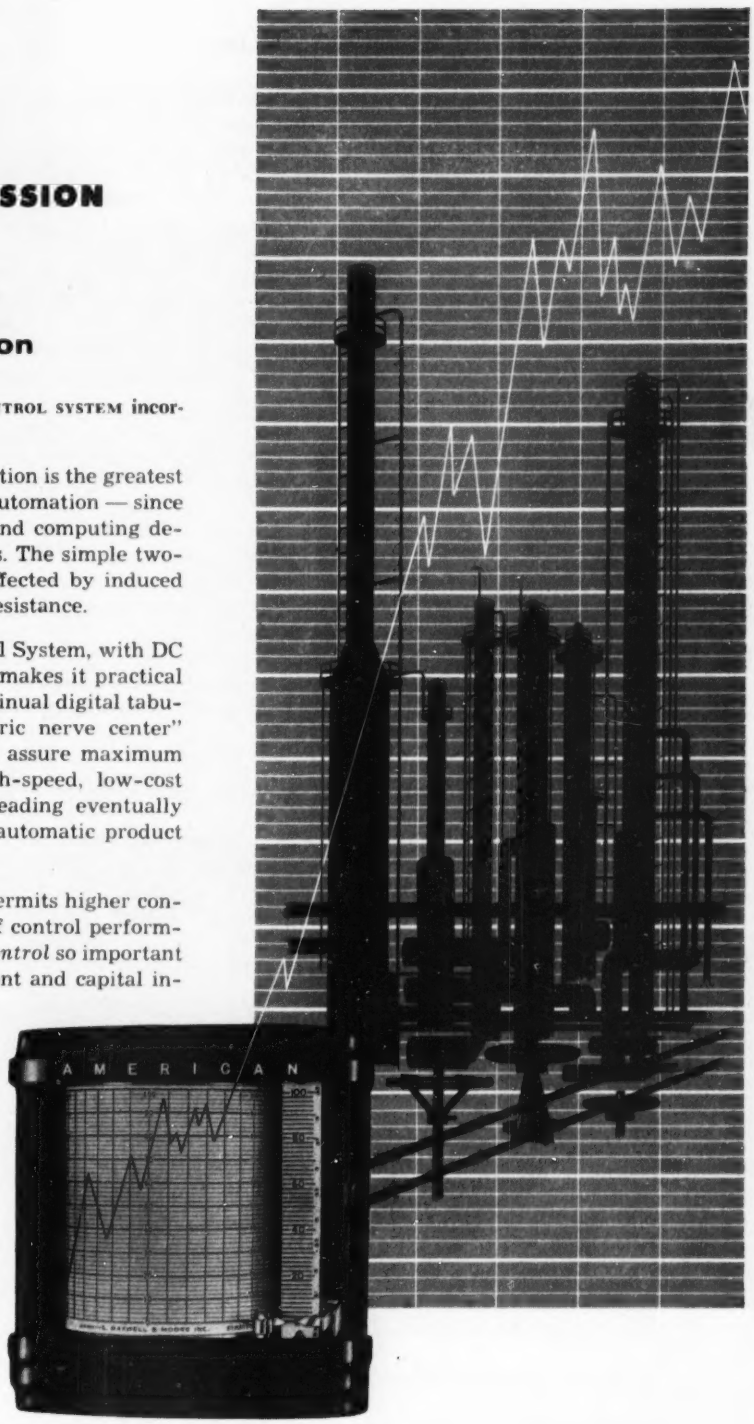
Only the AMERICAN-MICROSEN PROCESS CONTROL SYSTEM incorporates this engineering achievement.

DC TRANSMISSION of process information is the greatest compatability factor for complete automation — since most electronic print-out, monitoring and computing devices use DC in their measuring circuits. The simple two-wire DC communication lines are unaffected by induced alternating currents and varying line resistance.

The American-Microsen Process Control System, with DC transmission of process measurements, makes it practical to use automatic equipment for (1) continual digital tabulation of operational data; (2) "electric nerve center" supervision of all measured criteria to assure maximum safety and efficiency; (3) precise high-speed, low-cost accounting and engineering analysis leading eventually to the ultimate in automation — fully-automatic product analysis and control.

Instantaneous DC signal transmission permits higher controller gains — creates a new concept of control performance. It offers the *improved quality of control* so important in reducing the size of process equipment and capital investment for a given through-put.

The all-encompassing advantages of the American-Microsen Process Control System assure the highest reliability of instrument performance, minimum maintenance and the utmost in flexibility—all vital to the economical operation of the ultra modern plant of today and the standard plant of tomorrow. Your inquiry is invited. Write for Catalog 164.

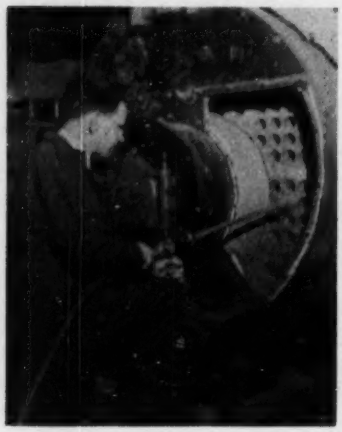


AMERICAN

MICROSEN INDUSTRIAL INSTRUMENTS

A product of **MANNING, MAXWELL & MOORE, INC.** STRATFORD, CONN.

MAKERS OF 'AMERICAN' AND 'AMERICAN-MICROSEN' INDUSTRIAL INSTRUMENTS, 'HANCOCK' VALVES 'ASHCROFT' GAUGES, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, AIRCRAFT PRODUCTS. BUILDERS OF "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES.



Percussion Lance

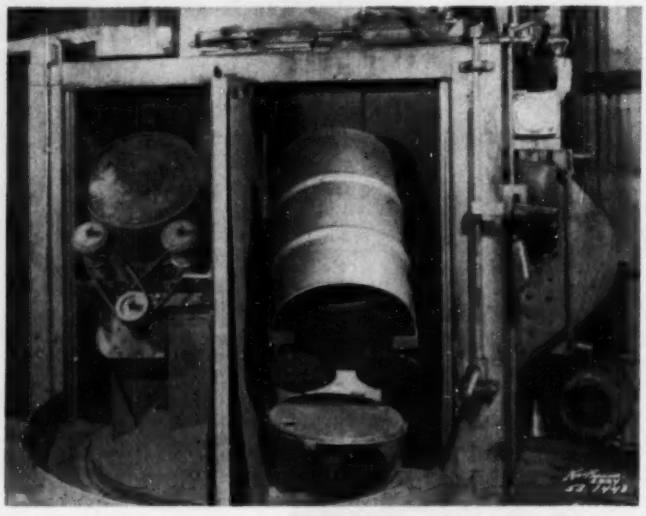
Cleans boiler tubes faster and more economically.

Tube surfaces in flame or water tube boilers, economizers and air preheaters are easily freed of soot, ash or clinker by the action of a new cleaning tool. Operating on compressed air (20 cu. ft. of free air per min. at 100 psi.) or steam (110 lb. per hr. at 105 psi.) the Airnesco boiler cleaning Percussion Lance produces 1,500 pulsations per min.

When cleaning fire tube boilers all you do is to insert the lance six inches into the tube. Release of three or four bursts by simple trigger action cleans the entire inner surface.

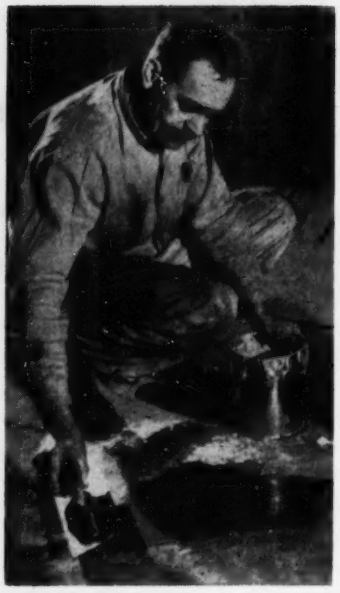
It is said to clean a 300-tube waste heat boiler in 30 min. The fire side of water-tube boilers is cleaned by the high frequency shock action of the blasts without even taking the boiler off the line.

Adapter extensions permit use of the tool for many other jobs ranging from dust removal on large electric generators to the trimming of bunkers. **C. F. Carpenter, P. O. Box 87, Allentown, Pa.** **274A**



Cleaner Reconditions Drums Before Repainting

Operating like a revolving door this machine cleans drum surfaces by abrasive blasting prior to painting or coating. On closed-end drums only the exterior is cleaned; on open-end drums both interior and exterior together with lid are blasted. Table is rotating to bring clean drum out on the right and carry dirty drum into the blasting booth on the left. Partition in center keeps blasting zone completely enclosed. Abrasive is hurled centrifugally by a rotating bladed wheel mounted in the rear wall of the cabinet.—American Wheelabrator & Equipment Corp., Mishawaka, Ind. **274B**



Floor Patching

Sets within minutes, avoids traffic stoppages, gives smooth, tough surface.

Cracks and holes that develop on interior concrete floors can be fixed quickly and permanently by using a new patching compound. Only 45 min. separate the last smoothing stroke of the trowel from passage of the first wheel across the patched surface. And the Kwik-Roc patch is said to have more than twice the compressive strength of average floor concrete.

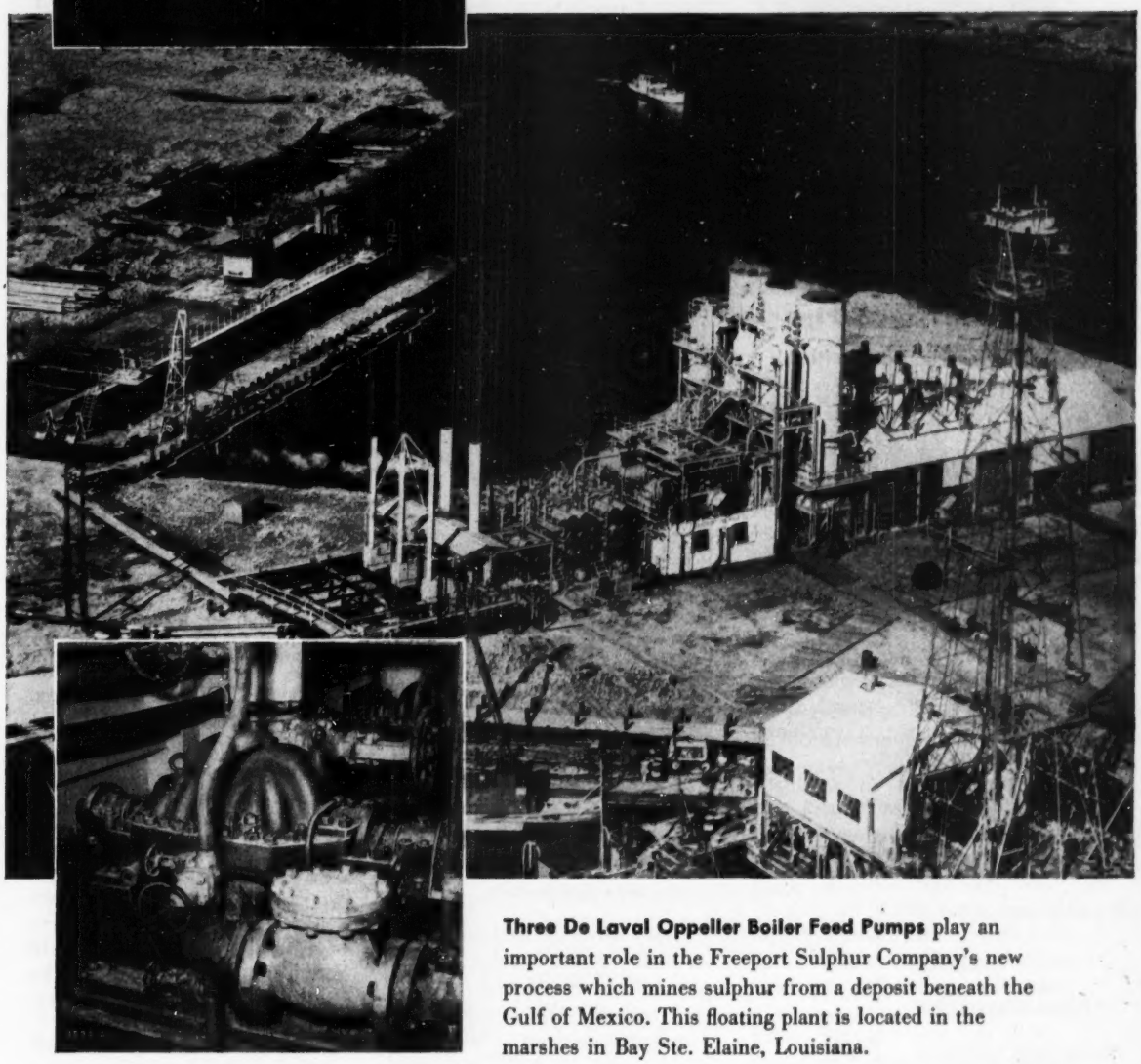
Kwik-Roc powder is mixed with water then poured into the clean hole or crack and leveled with the floor. It is not recommended for resurfacing entire floor areas, for use on interior floors that are constantly wet or subject to water or acid spillage or for exterior surfaces.—**A. C. Horn Div., Sun Chemical Corp., Long Island City, N. Y.** **274C**

For More Information . . .

about any item in this department, circle its code number on the Reader Service Postcard inside the back cover.

DE LAVAL OPPELLER PUMPS

are used for boiler feed on floating process plant



Three De Laval Oppeller Boiler Feed Pumps play an important role in the Freeport Sulphur Company's new process which mines sulphur from a deposit beneath the Gulf of Mexico. This floating plant is located in the marshes in Bay Ste. Elaine, Louisiana.

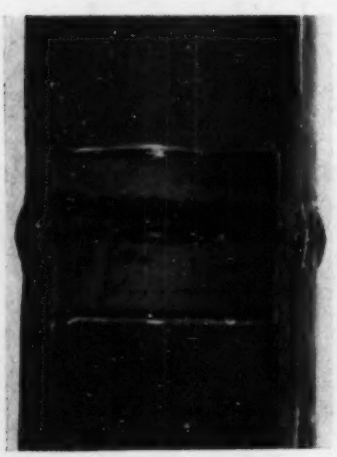
The De Laval Boiler Feed Pumps operate at 3,500 rpm with water heated to 297F. They are built with 12% chrome steel impellers and trim. The dependable performance of these units has led Freeport Sulphur to purchase six additional pumps for boiler feed service at two other mines. In addition to boiler feed, De Laval Oppeller Pumps are used throughout industry for mine dewatering, descaling, desuperheater feed as well as for services in the petroleum, pipeline and marine fields. Capacities range up to 2,000 gpm, pressures to 1,200 psig, temperatures to 350F; materials to suit any service. For complete data, send for Catalog 1502.

DE LAVAL *Oppeller Pumps*

DE LAVAL STEAM TURBINE COMPANY

803 Nottingham Way, Trenton 2, New Jersey

BL-800



Porcelain Lined Pipe

Now can be joined without impairing coating.

High cost custom building of glass-lined pipe now can be practically eliminated by a new pipe-joining method. Costs of installed systems will be reduced, lower pipe production costs will be possible and new high temperature applications now will be practical.

Basically, the method allows pipe to be joined in the field without impairing the characteristics of the coating. The joint formed equals the original coating in continuity and resistant qualities.

Variations in diameters, thickness of coating, ovality and connections to other piping materials will not interfere with weld.

The procedure consists of cutting the pipe to size so that the ends are fairly square. The cut end of each section is fitted with a glass-coated insert that is rolled or expanded into the end of the pipe.

Next the pipe ends are butted and oxy-acetylene welded with high alloy filler rod. Heat of welding serves to fuse together the glass on insert and pipe lining. This seals off any possible penetration path for corrosive liquids to reach the steel base metal of the pipe. After the weld is completed the only metal exposed is the high alloy material which is not subject to corrosive attack.—**Barrows Porcelain Enamel Co., Langdon Rd. and Penn R. R., Cincinnati, Ohio** 276A

Industrial Flooring

Unaffected by chemicals, oil or grease is tough.

Manufactured in either strips or blocks Gam-En-Wood flooring is resistant to wear and the action of oil, chemicals or grease. Also it is non-conductive, fire-resistant, and non-slip.

Gam-En-Wood is a laminate of Enrup rubber-based plastic bonded to solid or laminated hardwoods.—**Gamble Brothers, Inc., 4601 Louisville Ave., Louisville, Ky.** 276B

Steel Structures

Now fastened with bolts, nuts and washers.

Heavy structural steel framework for buildings now is being fastened with bolts, nuts and washers rather than with the time-honored rivet. The bolted joints are claimed easier and safer to install and good for the life of the building.

Powerful clamping force transmitted through the washers gives increased strength. A special heat treatment enables the washers to resist surface abrasion, thus transmit the clamping force without gouging or scoring. Also the washers have sufficient ductility to form with the structural steel members. —**U. S. Steel Supply Div., U. S. Steel Corp., 208 So. LaSalle St., Chicago 4, Ill.** 276C

Pipe Insulation

One-piece molded of glass fiber now made in wide size range.

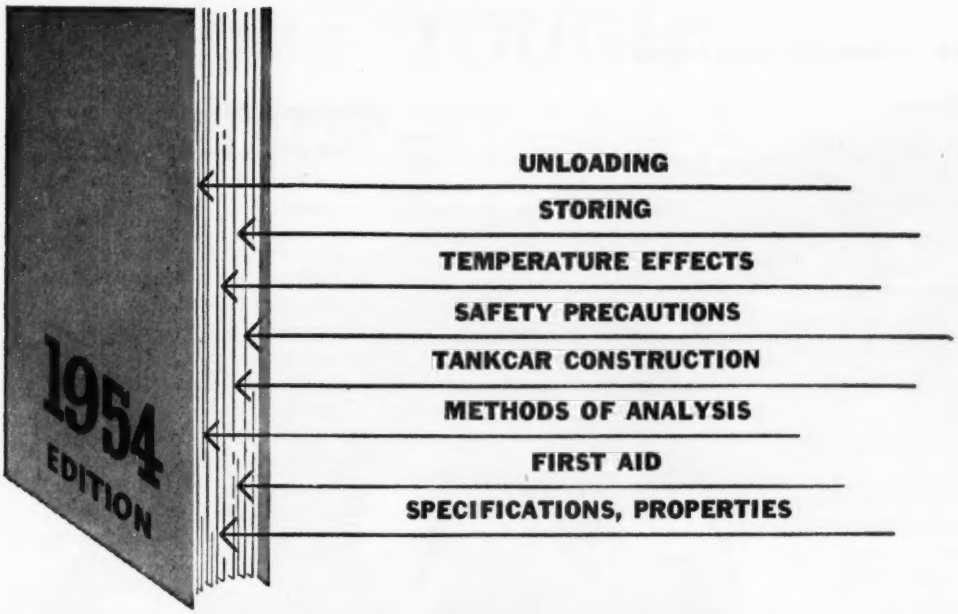
Hot and cold piping from ¾ to 24 in. dia. now can be covered with G-B Snap-On pipe insulation. Originally introduced one year ago this insulation has been available only in a limited range of sizes up to the present.

Molded in one piece of fine glass fibers G-B Snap-On comes in 3-ft. lengths in diameters to 2 in. and 6-ft. lengths in the larger diameters. Wall thicknesses of ½, ¾, 1, and 1½ in. are available in sizes up to 12 in.; and 1, 1½ and 3 in. for piping above 12 in. dia.

To use, you merely spread the Snap-On insulation open at the single seam and snap it over the pipe. The seam is joined tightly with staples or other conventional means. —**Gustin-Bacon Mfg. Co., 210 West 10th St., Kansas City, Mo.** 276D

Stainless steel, ELC grade, available in larger quantities now that Cooper has expanded facilities by 6 tons of metal per day. ELC can be welded without heat treating.—**The Cooper Alloy Foundry Co., Hillside, N. J.** 276E

Silicone-rubber O-rings furnished with coating of Kel-F. Combines chemical resistance with good properties from −120 to +390 F.—**Bacon Industries, Inc., 192 Pleasant St., Watertown, Mass.** 276F



CELANESE* FORMALIN MANUAL

Your non-technical personnel will find the Celanese Formalin Manual clear, concise, and easy-to-follow. Based on years of field experience with Formalin, this 1954 Edition has been brought completely up-to-date with the latest handling and storing procedures.

For technical personnel, it describes effects of temperature, basic reactions causing paraformation, and general information concerning construction materials for storage and handling equipment.

Users of Formalin will find this manual valuable in bridging the gap between engineers and non-technical operators. It is a must for plant safety training programs.

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Process Burner

Controlled by varying air pressure is intended for multiple unit installation.

In the Series 620-P line of burners, control is achieved by varying the pressure in the air supply line. They are designed for use as multiple units on furnaces, ovens and kilns with control from a central location.

Air-oil ratio and capacity are controlled through a single valve control in the combustion-air supply line serving the group of burners. The varying air pressure is then cross-connected to an air-oil ratio regulator for integrated varying of the pressures.

Flame characteristics can be changed from a short bushy shape through intermediate ranges to a long narrow profile merely by moving a flame adjusting lever. This lever has an indicator dial and locking nut.

Burners are available either for oil or combination oil and gas service.–**Hauck Mfg. Co., 124-136 Tenth St., Brooklyn 15, N. Y.** 278A

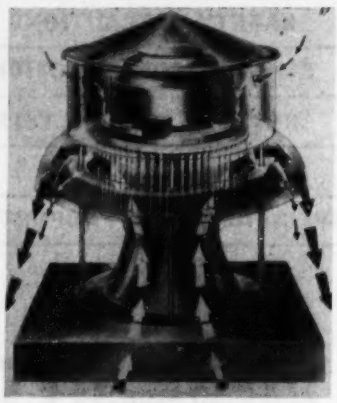
Dowtherm Vaporizer

Built as package is designed for 4 million Btu. per hr.

Designed for close coupling with process units the new Eclipse horizontal Dowtherm vaporizer can handle vapor and liquid phase heating requirements up to 4 million Btu. per hr. Furnished as a complete package the vaporizer is ready to go once fuel, electricity, stack and Dowtherm piping are connected.

Among the design features are ability to operate with low liquid level permitting the use of a gravity-return condensate system. At the same time all heating surfaces are below liquid level to protect tubes from burning and to increase efficiency.

Large enclosed furnace is said to provide high heat output without strain. The heating cycle can be automatically controlled to meet specific cycle requirements. Unit can operate on gas, combination gas or light oil, combination gas or heavy oil, oil only or heavy oil only.–**Eclipse Fuel Engineering Co., 1002 Buchanan St., Rockford, Ill.** 278B



Power Exhauster

With axial-air-gap motor safely handles hazardous fumes.

Model B power exhauster is claimed able to handle hazardous fumes without need for an explosion-proof motor in most cases. Designed around an axial-air-gap motor the unit employs cooling air from the motor to prevent collection of fumes within the motor.

Flow of air is shown in the phantom drawing above. The larger arrows indicate the main air stream coming up through the inlet nozzle, into the squirrel-cage fan housing and out through the weatherproof outlet. The smaller arrows show fresh air flowing through the motor hood, around the motor and motor shaft and out through the fan housing and weatherproof outlet. This latter action prevents entry of corrosive or explosive fumes into the motor chamber.

The weatherproof outlet of the Air-Van prevents blowback even under the most extreme weather conditions. Backdraft dampers are not necessary.

Use of the axial-air-gap motor has reduced the size and weight of the exhauster. Unit capacities run up to 12,000 cfm. and 5 hp.–**Gallaher Co., 4106 Dodge St., Omaha, Neb.** 278C

Heating Mantle

For process equipment can withstand heavy, punishing usage.

The Glas-Col R is a new electric heating mantle for heating process units to 650 C. It features a new, rugged fabric able to withstand the punishing treatment of pilot plant and production usage.

Woven into the Glas-Col R fabric, spirally from the bottom up, is a Nichrome resistance-wire element. Spacing between turns of the resistance wire is close at the bottom of each mantle, increasing toward the equator of the kettle or vessel.

Heat input is, therefore, greatest around the bottom center and less along the flask walls. Mantles for larger equipment have multiple circuits for more precise temperature control as liquid level varies. By this means solids buildup is avoided on walls above liquid.

Glas-Col R mantles are available for equipment sizes from 1 to 200 gal.–**Glas-Col Apparatus Co., Inc., 711 Hulman St., Terre Haute, Ind.** 278D

Corrosion-resistant immersion heater of impervious graphite is for service involving nitric acid. A plastic-coated steel hanger assures proper location of the HN Norcordal heater.–**Heil Process Equipment Corp., 12901 Elmwood Ave., Cleveland 11, Ohio.** 278E

Flange-type immersion heater operates on either a.c. or d.c. circuits at 115 or 230 v. and up to 125 psi. Calrod elements give high watt density.–**General Electric Co., Schenectady 5, N. Y.** 278F

For More Information . . .

about any item in this department, circle its code number on the Reader Service Postcard inside the back cover.

HANDLING "TOUGH" MATERIALS?—

Left: A 60' Carrier Natural-Frequency screening conveyor for clay products, with 24" pan made of ¼" steel plate. Capacity: 100 tons of 100-pound material per hour. 5 H.P. drive. Middle section of screen removed to show supporting bridge.

Above: Close-up of drive—note patented drive linkage which always places weight of vibrating pan and conveyed materials on the spring supports, and never allows these loads to be imposed on the eccentric shaft and bearings.

—ANYTHING that's hot, sharp, powdered, oily, abrasive, sticky, granulated or stringy?

CHECK THESE ADVANTAGES!

HIGH CONVEYING SPEED
(Up to 100 feet per minute)

GREATER CAPACITY
(Up to 200 tons per hour)

LESS POWER REQUIRED
(About one-third as much as "competitive" equipment)

LESS MAINTENANCE & DOWN-TIME
(Less power+good design= trouble-free performance)

NO DAMPENING UNDER LOAD
(Designed with extra power for specified load, with positive stroke)

SELF-CLEANING
(Continuous, smooth trough —no pockets)

COMBINES PROCESSING WITH CONVEYING
(Can screen, dry, cool, dewater, blend, etc.)

WIDTHS FROM 6" TO 48" LENGTHS FROM 5' TO 250'
(With pans 16 ga to ½" plate, of any metal, open or enclosed)

BALANCED, VIBRATION-FREE UNITS AVAILABLE
(For use on ceilings or light floor construction)

CARRIER NATURAL-FREQUENCY CONVEYORS

Carrier Natural-Frequency Conveyors work on a unique, patented vibrating principle which permits them to handle many materials that are too "tough" for most screw, belt, apron, vibrating and other conventional types of conveyors. These spectacular new conveyors also substitute the natural resonance action of coil springs for brute force. Result—*a tremendous reduction in power . . . far less wear-and-tear . . . and an absolute minimum of maintenance and down-time!*

Carrier Natural-Frequency Conveyors — including vertical vibrating spiral types — are now racking up amazing conveying records for scores of America's biggest, most successful industrials. Let us prove to you that they will move *your* product more quickly, efficiently and economically. *Mail the coupon — no obligation of course!*

Carrier Conveyor Corporation
2106 Frankfort Avenue, Louisville 6, Kentucky

Gentlemen:

Without obligation, please send me Carrier Natural-Frequency Conveyor Bulletin No. 111.

Firm_____

Street_____

City_____ State_____

Att. Mr._____ Dept._____

Shoe Covers

Prevent spread of contamination from radioactivity.

Although clownish in appearance, these vinyl-coated canvas shoe covers serve a real purpose. Worn over ordinary shoes they minimize spread of radioactive contamination. They can be used also to prevent tracking other types of contamination.

Actually the covers do not protect against radiation. Rather they are worn in contaminated areas then removed to avoid tracking contamination into other areas.

Vinyl coating over canvas makes a tough, flexible, abrasion-resistant surface for the soles of the canvas covers.—**Flexible Products Co., Marietta, Ga.** 280A

Fire Hood

Has built-in safety helmet to protect against falling objects.

Protection against falling objects has been added to the standard protective features in the new Issco fire hood. A fully adjustable hard safety hat, riveted into the top of the hood, gives this added protection.

Hood is made of aluminized asbestos for greater heat deflection and is fireproof throughout. It is said that the shiny aluminum surface reflects over 80 percent of the heat away from the head and face of the wearer.

Weighing less than 4 lb. the hood is roomy and pliable, permitting full freedom of movement even when breathing apparatus is worn. It can be put on in seconds.—**Industrial Safety Specialties Co., Perkasie, Pa.** 280B

Fire Blanket

Located in quick-release wall canister saves time.

When you need a blanket for emergency fire extinguishing or first aid this wall canister serves your needs. Seconds saved in stopping clothing fires may lessen personal injury and avoid loss of life.

Mounted in a conspicuous location and painted a firehouse red the canister stands ready when the need arises. The bottom-opening lid has a handle extending beyond the body for easy grasping. Lid opens fully permitting blanket to fall free instantly. In the closed position lid is held in place by spring steel clip.—**Industrial Products Co., 2820 North Fourth St. Philadelphia, Pa.** 280C

Hand Truck Guard

Protects operator from injury when hand truck slips.

This operator will never be hurt if the hand truck slips from his grasp. He is protected by the Swinguard device attached by heavy-duty clamps to the back of the truck.

Here is how it works: If the truck should drop back toward the operator the Swinguard touches the floor. Then the weight of the load thrusting through the Swinguard against the floor pushes the truck away from the operator's legs. The free-swinging attachment also acts as a skid on the forward motion to keep the hand truck at a slight angle when at rest.—**Twin-Tilt Truck Co., Apple & Vandalia St., Cincinnati, Ohio.** 280D

Portable Fire Pump

Driven by gas turbine equals pumping rate of heavy trailer-mounted units.

A 60 hp. gas turbine coupled to a 500 gpm. centrifugal pump provides a compact light-weight fire fighter with the punch of a heavy weight. From a cold start the Sigmund Rover pump can be operating within 15 sec.; primes at a minimum of 1 ft. per sec. up to 24 ft. lift.

Turbine and pump are close coupled and mounted within a tubular-steel frame fitted with carrying handles. Total weight is 215 lb. Turbine will run on gasoline, diesel or any other distillate fuel.

Pump rotates at 4,500 rpm. The suction branch has a 4 in. bore while discharge is through two 2½ in. outlets.—**Sigmund Pumps, Ltd., Team Valley, Gateshead 11, England.** 280E

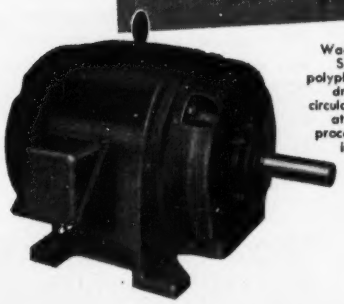
For More Information . . .

about any item in this department, circle its code number on the Reader Service Postcard inside the back cover.

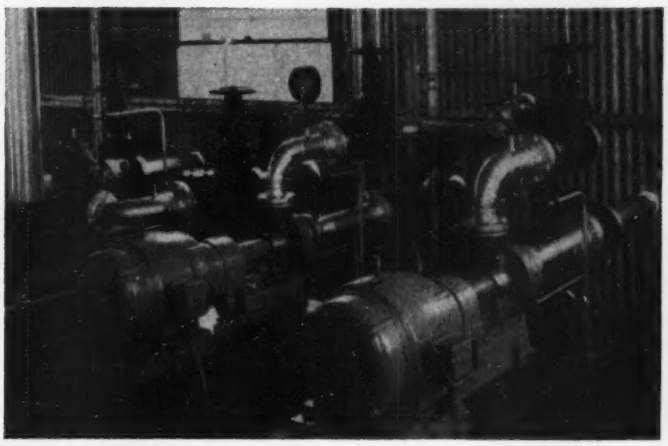
Wagner®
ELECTRIC MOTORS
...the choice of leaders in industry

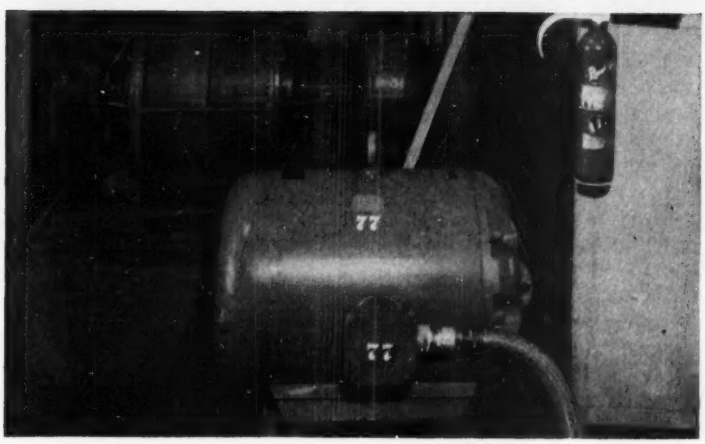
You can *depend* on Wagner Motors to furnish *PLENTY OF POWER* for compressors, pumps or blowers

PUMPS



Wagner 15 hp Splash-proof polyphase motors driving water circulating pumps at a large oil processing plant in Louisiana.





BLOWERS

Wagner 40 hp Explosion-proof motor driving a blower to draw grain into a hopper at a Southern brewery.

Motors that drive compressors, pumps and blowers need plenty of electrical and mechanical stamina to hold up under the hard, steady grind demanded by these applications.

Selecting the right motor for such equipment is not a problem of procuring specially built motors, but of choosing a standard Wagner Motor suited to the job. Wagner Motors are diversified in design and can be readily adapted to a wide range of compressor, pump and blower applications.

Improve the performance of your equipment by choosing Wagner Motors to power your compressors, pumps and blowers.

Bulletin MU-185 gives information on the complete line. Let a skilled Wagner engineer discuss your motor needs with you. Just call the nearest of our 32 branch offices, or write us.

Wagner Electric Corporation
EST. 1891

WAGNER ELECTRIC CORPORATION
6407 PLYMOUTH AVE., ST. LOUIS 14, MO., U.S.A.

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ELECTRIC MOTORS
TRANSFORMERS
INDUSTRIAL BRAKES
AUTOMOTIVE BRAKE SYSTEMS—AIR AND HYDRAULIC

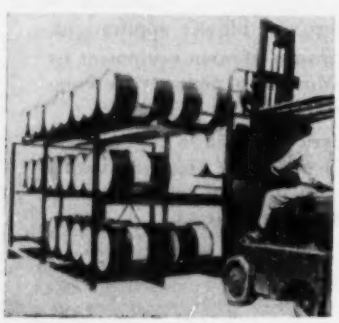
M54-6A

Bulk Conveyor

Uses two-directional chain to convey in any direction.

Conveying bulk solids through a square tubular section this two-directional chain moves in any direction. The infinite angular relationship indicated in the picture is possible because of the two-directional linkage. Operation in more than one direction is possible without transfer points.

The two-piece flight can be replaced without dissassembly of the chain. High graphite cast iron is the standard flight material giving strong, self-lubricating, quiet operation. Also high temperature has no adverse effect.–**Prab Conveyors, Inc., 19815 East Nine Mile Rd., St. Clair Shores, Michigan** 282A



Drum Rack

Feeds by gravity, saves labor and space.

Design of this drum rack permits unloading either from the downhill end or from the side. As a drum is removed another one moves by gravity to take its place. Drums are loaded on rack from the uphill end.

Rack is built of structural steel with a rated capacity of 500 lb. per drum; total capacity is 54 drums. Component parts shipped knocked down are six rail panels, three column panels, two sets of diagonal rods and six stop brackets. Two men can assemble it completely in less than one hour.–**Johnson & Flaherty, 5801 District Blvd., Los Angeles 22, Calif.** 282B

Belt Conveyors

For short hauls can be assembled from standardized components for the first time.

Until now if you needed a belt conveyor for hauls less than 40 ft. you doubtless had to construct it of components designed for higher horsepowers than needed, or have it specially designed.

Now for the first time standardized components are offered to form conveyors ranging from 8 to 44 ft. in length, in increments of 1 ft. Available belt widths are 18, 24 and 30 in.; handle capacities of 50 to 480 tons per hr.

Assembly is mounted on a 5-in. channel frame and can span 15 ft. between supports. Other features include 4-in. dia. ball-bearing troughing carriers and full Alemite lubrication. – **Barber-Greene Co., 400 North Highland Ave., Aurora, Ill.** 282C

Storage Bins

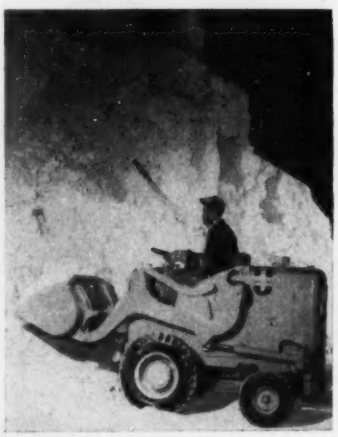
Designed for buildings with limited head room.

Suitable bulk-storage bins now have been developed for space with limited head room. Constructed to meet sanitary requirements the horizontal bolted bin is only 11 ft. high and can be furnished in almost any length. Screw discharge can be provided.–**The Day Co., Minneapolis 13, Minn.** 282D

Fork Trucks

Modified and approved for operation on LPG fuel.

A fork-lift truck powered by liquified petroleum gas (LPG) has received approval and listing by Underwriters' Laboratories. The standard model 3,000-5,000 lb. Carloader is factory modified for LPG operation. LPG fuel is desirable for indoor operations because the combustion fumes are colorless and odorless. The engine has an 8 to 1 compression ratio and special valve design to avoid burnout.–**Clark Equipment Co., Battle Creek, Mich.** 282E



Tractor Shovel

Speeds up bulk handling in plant, yard or car.

Nimblefootedness is a built-in feature of the 12 cu. ft. Load-Plus tractor shovel. Design aims at speeding up the one-man handling of bulk materials.

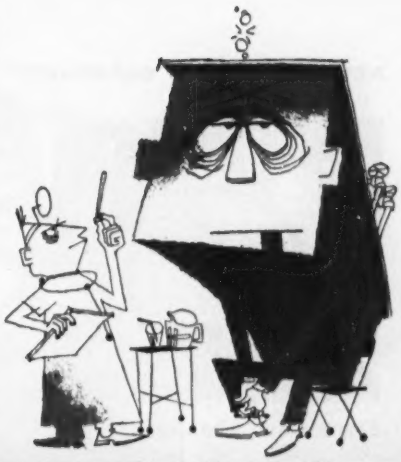
Machine has lifting capacity of 1,200 lb., reverse speed of 13.88 mph., forward speed of 7.66 mph., turning radius of 6.5 ft., dumping clearance of 4.5 ft. and reach of 2 ft. 7 in.

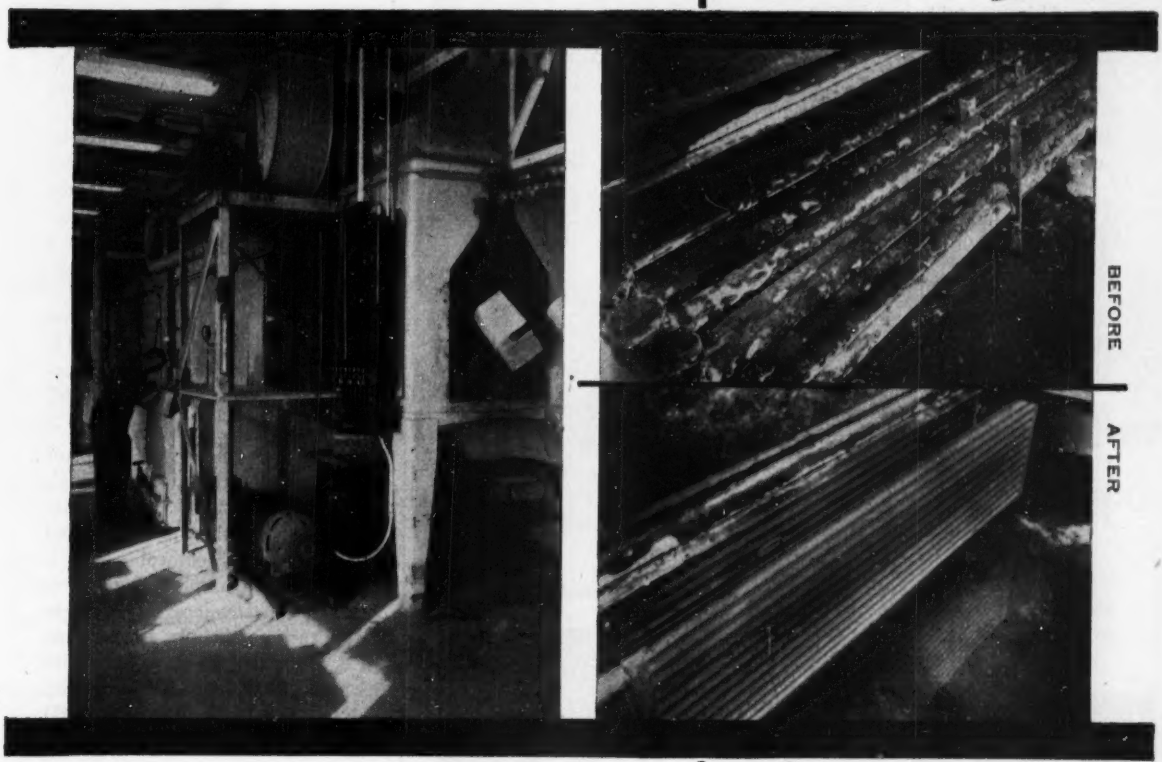
During operation the boom arms crowd the bucket forward as it rises. Two double-acting bucket control pistons tilt the bucket back to level position to avoid spilling. A single 4-way hydraulic valve controls both boom arms and bucket. –**The Jaeger Machine Co., Columbus, Ohio.** 282F

warm-up time reduced 75% as

PLATECOILS cure coil-itis*

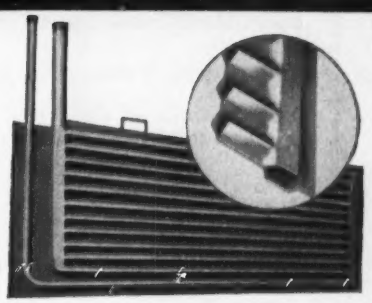
Burroughs Corporation has reduced warm-up time in their phosphate coating system from 2 hours to 1/2 hour by replacing original pipe coils with Platecoils. They have also saved $1,440 a year in maintenance costs as the pipe coils coated badly and required chipping at least once a month while the Platecoils have required no maintenance in over a year. In addition, the Platecoils cost less to install and take 50% less space in the tank.



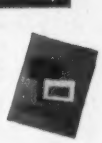


PLATECOILS replace pipe coils for 50% of the cost

* Coil-itis is the constant doctoring of wet processing tanks for pipe coil troubles. It can be cured easily by replacing pipe coils with Platecoils. Immediately, you will notice the difference as Platecoils put new life and profits into your heat transfer processes. They heat or cool 50% faster and take 50% less space in the tank. They save as much as 50% in initial cost and 50% in maintenance costs in addition to overcoming the limitations and operating difficulties of old-fashioned and outmoded pipe coils.

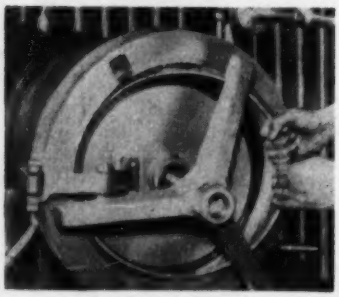


Bulletin P61 shows how Platecoils are replacing pipe coils at a savings throughout industry. Send today for your copy.



Platecoil Division, TRANTER MANUFACTURING, Inc., Lansing 4, Michigan

For fast shipment see your local distributor



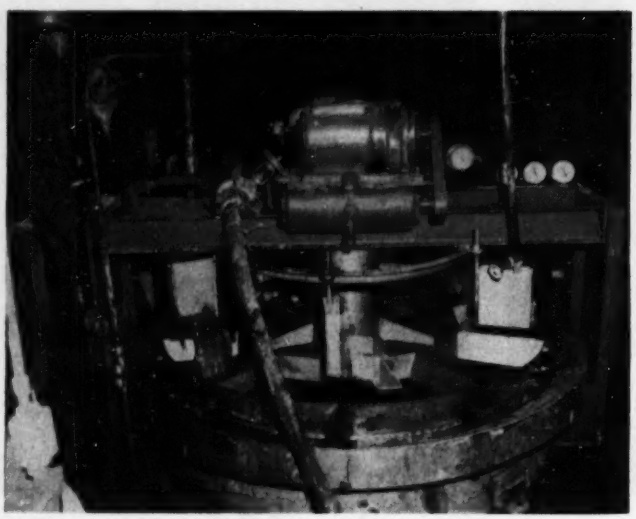
Pressure Closure

Using metal-to-metal contact, seals tighter as pressure increases.

Operator inserts flexed metal gasket ring between opposing tapers on plug and vessel wall preparatory to sealing closure. By tightening the spider nut the gasket will be held in compression between the plug and the weld neck. The resulting metal-to-metal contact will seal more tightly as pressure rises.

Flex Ring closures consist of four main parts: weld neck, plug, gasket and spider. Among the advantages cited over old-style flange closures are reduced opening and closing time, less weight, fewer parts, tighter seal, increased safety; savings on cost and space.

Closures have same pressure ratings as ASA flanges. Selection of materials, allowable stresses, etc., are in accordance with latest ASME codes.—**Sillers Engineering Co., Box 7193, Dallas, Tex. 284A**



New Filter Works Out on Phosphoric Acid

Pilot installation of Eimco pan-type filter at Jefferson Lake Sulfur Co., Wendell, Idaho removes from phosporic acid up to 180 lb. of gypsum per sq. ft. per hr. Unit recovers 96% of the available P_2O_5. A larger 60 sq. ft., 10 pan filter at St. Joe Lead Co.'s Indian Creek Mill at Potasi, Mo. dewaters −20, +100 mesh lead concentrate to a final moisture content of 5-7%. Filtration rate of 7,000 lb. of feed per sq. ft. per 24 hr. is classed as one of the highest in the industry. Eimco filter discharges cake by dumping from inverted pan aided by a snap blow. No heel is left on cloth and organic slimes are removed by high pressure sprays to prevent blinding. While closely similar in function to the Prayon (*Chemical Engineering*, June '54, p. 296) and Dorr-Oliver pan filters the Eimco claims to use less floor space, and shorter pipes; to have lower cost and the advantages of American production and availability.—Eimco Corp., 634 South Four West St., Salt Lake City, Utah. 284B

Hydraulic Classifier

Delivers sharply sized fractions from diversified feed.

More effective use of hydraulic water enables the Jet Sizer to split diversified feed into clean, deslimed fractions sized within narrow limits. This hindered-settling hydraulic classifier sizes and grades solids that are finer than eight mesh.

Classification is done within a number of individual compartments or pockets of equal area. A half-sized pocket scalps out the coarsest particles ahead of the classification banks.

Pocket arrangement is flexible; they can be situated singly in series or in transverse banks of two, three or four abreast. Sized fractions are discharged continuously through a valve mechanism which is controlled pneumatically.

Jet Sizer is available with any number of pockets from 1½ to 21½. —**The Dorr Co., Barry Place, Stamford, Conn. 284C**

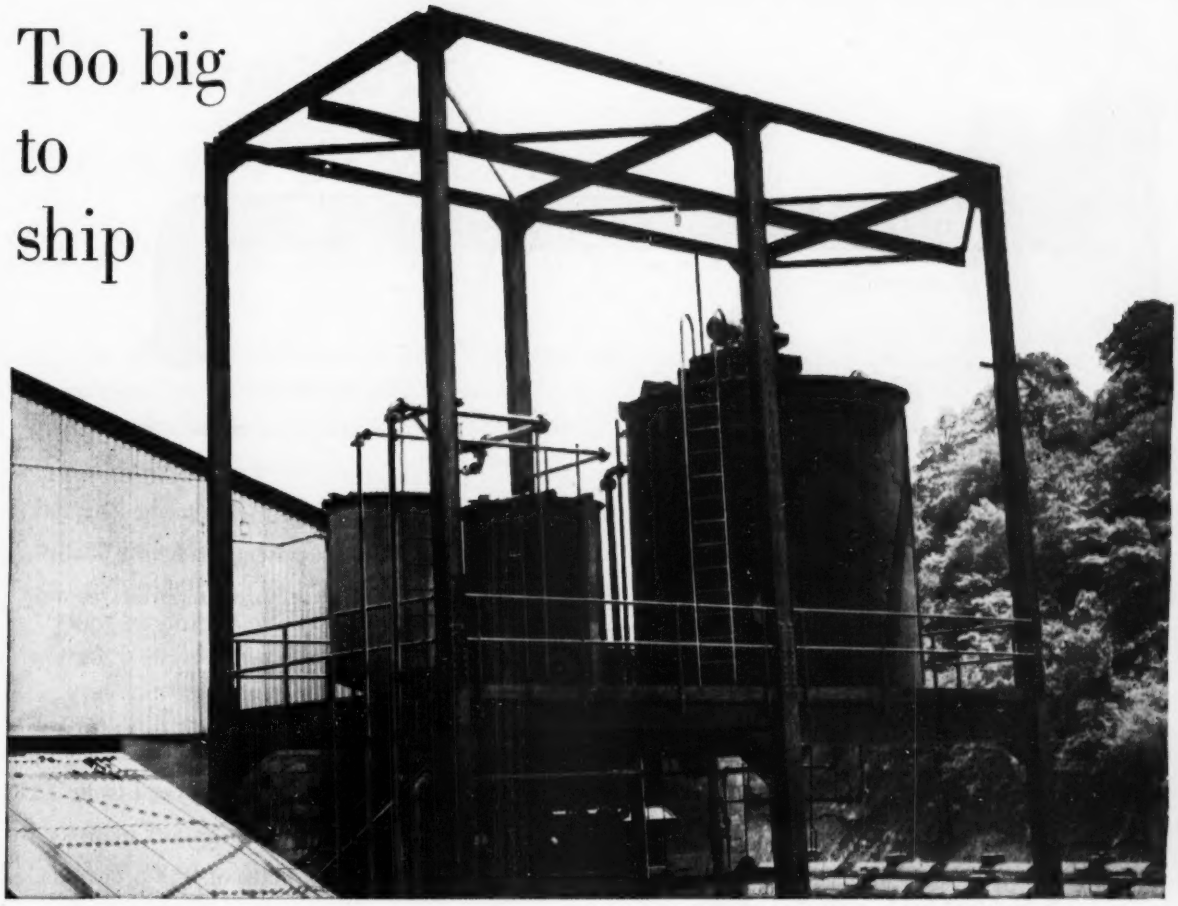
Portable spray dryer for pilot plant and small scale production is compact, easy to handle; has built-in electric and direct fired gas heaters. Electrical system is designed to simplify change-over from one voltage system to another. — **Nichols Engineering & Research Corp., Nerco-Niro Spray Dryer Div., 70 Pine St., New York 5, N. Y. 284D**

Water diffuser for cation and anion exchangers prevents windrowing and shifting of the resin bed. Individual diffusers are perforated plastic cylinders 5 in. high by 6 in. dia.—**Permutit Co., New York 36, N. Y. 284E**

For More Information . . .

about any item in this department, circle its code number on the Reader Service Postcard inside the back cover.

Too big to ship



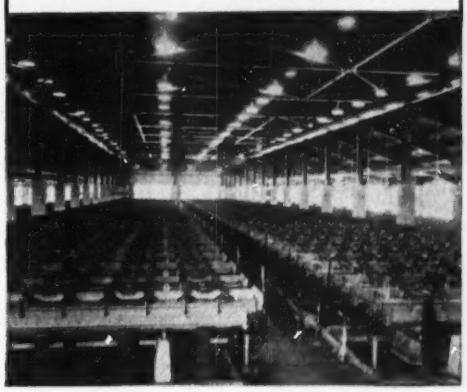
so U.S. Permobond® protective linings were installed on the spot

EQUIPMENT requiring protection against corrosive attack can be lined with Permobond linings—*right in your own plant*. The above storage tanks in a chemical plant, for example, were too big to be shipped. So United States Rubber Company's Permobond Lining was installed and vulcanized right at the job site—insuring complete protection against the corrosive chemicals stored in the tanks.

This is one more example of the versatility and adaptability of the Permobond process. You can also have it installed *as original equipment* on anything that contains or conveys corrosive materials and chemicals – piping, tanks, valves. And where special conditions occur, a wide range of synthetic Permobond lining stocks is available. Write to the address below.

U.S. RUBBER
SERVING THROUGH SCIENCE

These hundreds of electrolytic mercury cells producing caustic soda and chlorine are lined with specially compounded Permobond hard rubber lining.



"U. S." Research perfects it.
"U. S." Production builds it.
U. S. Industry depends on it.

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GUIDED TOUR CONTINUED

PICTURED FLOWSHEET

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CHEMICAL ECONOMICS

How an investor looks at chemicals **313**

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C. C. Furnas, chancellor of Univ. of Buffalo **320**

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Extractive distillation . . .

. . . is one of the process highlights of Shell's method of making butadiene. Here's a pictured flowsheet with important process data. (p. 306)

Invest in chemicals now?

Better take a second look. For getting into a growth industry is no guarantee of lush profits, may lead to a downfall. (p. 313)

C. C. Furnas does it again!

Top-notch chemical engineer —olympic athlete, track coach, author (Book of Month), teacher, editor, researcher—now becomes university chancellor. (p. 320)

New technical literature . . .

You can now get—free and fast—literature on any subject in your field. Use our new and enlarged section to keep your technical files up-to-date. (p. 444)

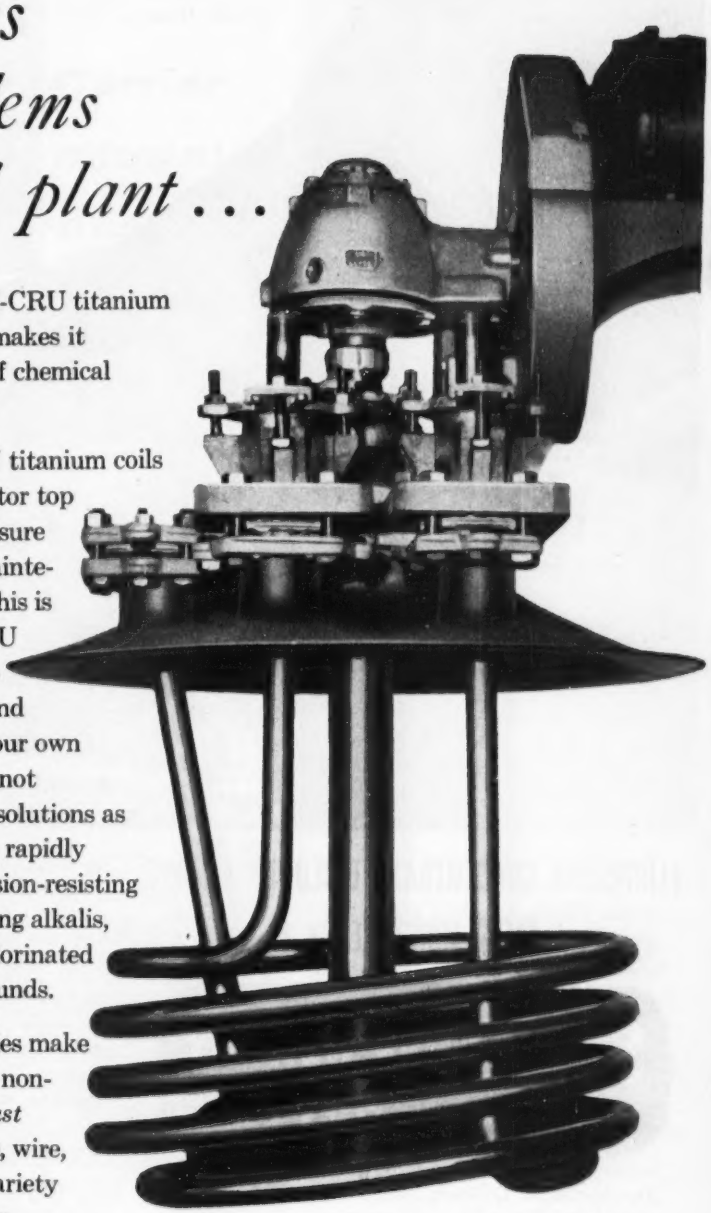
Join READER SERVICE on page 433

Titanium solves corrosion problems in the chemical plant . . .

The unmatched resistance of REM-CRU titanium to most forms of corrosive attack makes it the logical choice for many parts of chemical processing equipment.

Take, for example, the REM-CRU titanium coils and thermometer wells on the reactor top head assembly illustrated. They insure long service life, with minimum maintenance or loss of production time. This is just one example of how REM-CRU titanium pays its way in the chemical processing industry . . . you'll find dozens of similar applications in your own plant. For REM-CRU titanium is not attacked by such highly corrosive solutions as chlorides and hypochlorites, which rapidly attack other commonly used corrosion-resisting metals. It is also impervious to strong alkalis, sulphur or sulphur compounds, chlorinated solvents, and many organic compounds.

Now, too, greatly expanded facilities make REM-CRU titanium available for non-defense applications. You can get *fast* delivery of bars, plates, sheet, strip, wire, tubing and forgings . . . in a wide variety of sizes, grades and shapes. And the experience of REM-CRU engineers is backed by extensive data on titanium applications in the process industries. Let them help you make the most profitable use of REM-CRU titanium in your plant.



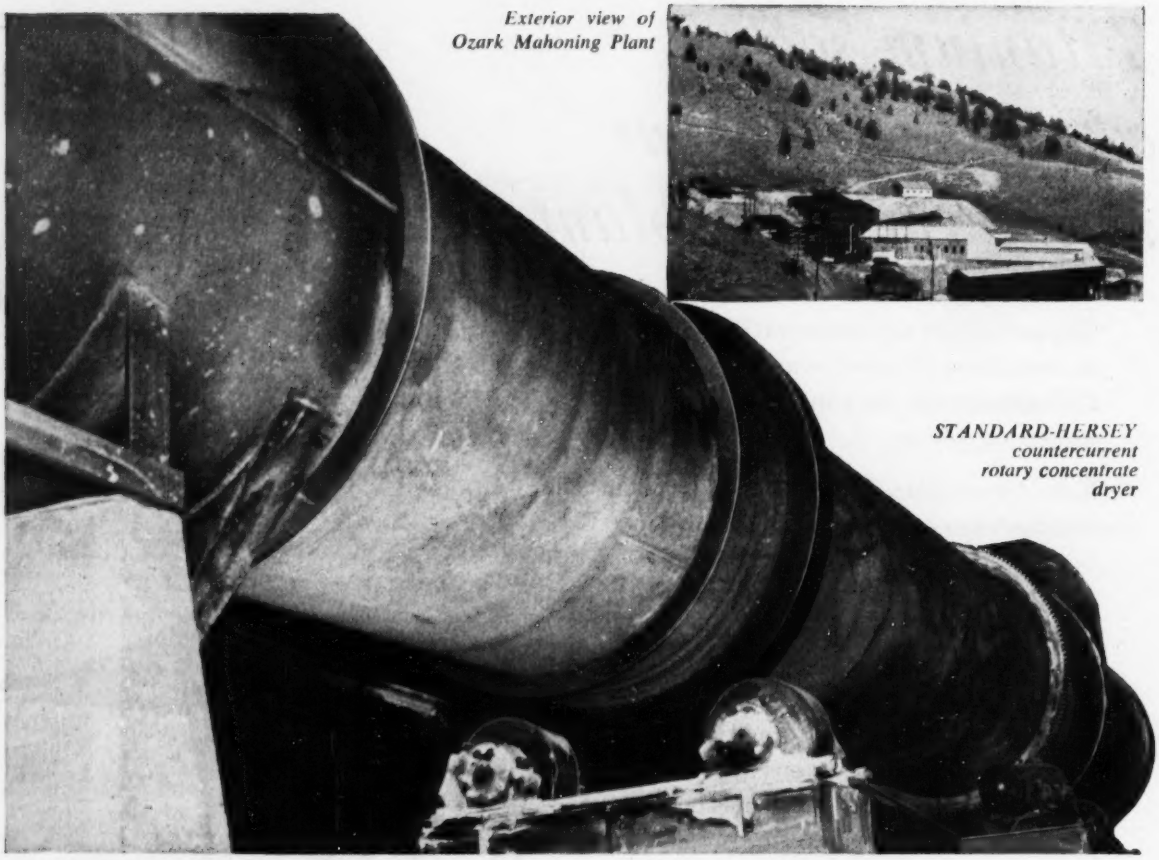
REM-CRU titanium was an excellent choice for coils and thermometer wells of this reactor top head assembly, fabricated by the Pfaudler Company.

To keep abreast of the latest developments on this vital metal, write for the Rem-Cru Review—a free periodical devoted to the application and fabrication of titanium alloys.

REM-CRU TITANIUM

REM-CRU TITANIUM, INC., MIDLAND, PENNSYLVANIA

Exterior view of Ozark Mahoning Plant



STANDARD-HERSEY countercurrent rotary concentrate dryer

FLUORSPAR CONCENTRATE DRIED TO ALMOST 0% MOISTURE BY A

STANDARD HERSEY ROTARY DRYER

The Northgate, Colorado plant of Ozark Mahoning Co. produces Acid Grade Fluorspar exclusively. Since their flotation concentrator went into production in October of 1952, output has increased to the point where their Standard-Hersey dryer *is now operating at 150% rated capacity.*

The filter cake, produced in Denver equipment, is transported by screw conveyer to a stacking belt for stock piling and sampling, or directly into the 6′ by 50′ Standard-Hersey countercurrent rotary dryer. Moisture in the concentrate is reduced by the dryer from 12-14% to approximately 0% for shipment.

The dryer is lined throughout its length with refractories, as is the dryer furnace. Exhaust gasses at 350°F. pass through a cyclone type dry dust collection system with a balanced airlock arrangement. The temperature of the discharge product is 450°F. Semi-automatic burner controls provide efficient operation of the dryer unit.

The unusually large diameter of the dryer was selected to minimize the velocity of the gas stream through the dryer thus reducing concentrate dust loss to an estimated 1-ton of concentrate per 24 hours.

The engineering staff of the 52 year old Standard Steel Corporation has thousands of successful dryer applications to draw on in solving your problems. Over 30 types of dryers are available to fill almost every drying need in the chemical and food fields.

SEND FOR FREE 12-PAGE ILLUSTRATED BULLETIN

Learn how STANDARD-HERSEY has aided manufacturers throughout the world in solving their dryer problems.

COMPLETE PILOT PLANT TAKES GUESSWORK OUT OF DRYING

STANDARD-HERSEY'S pilot dryers play an important part in solving your drying problems *before* blueprint stage.

THE STANDARD FOR 52 YEARS

STANDARD STEEL CORPORATION

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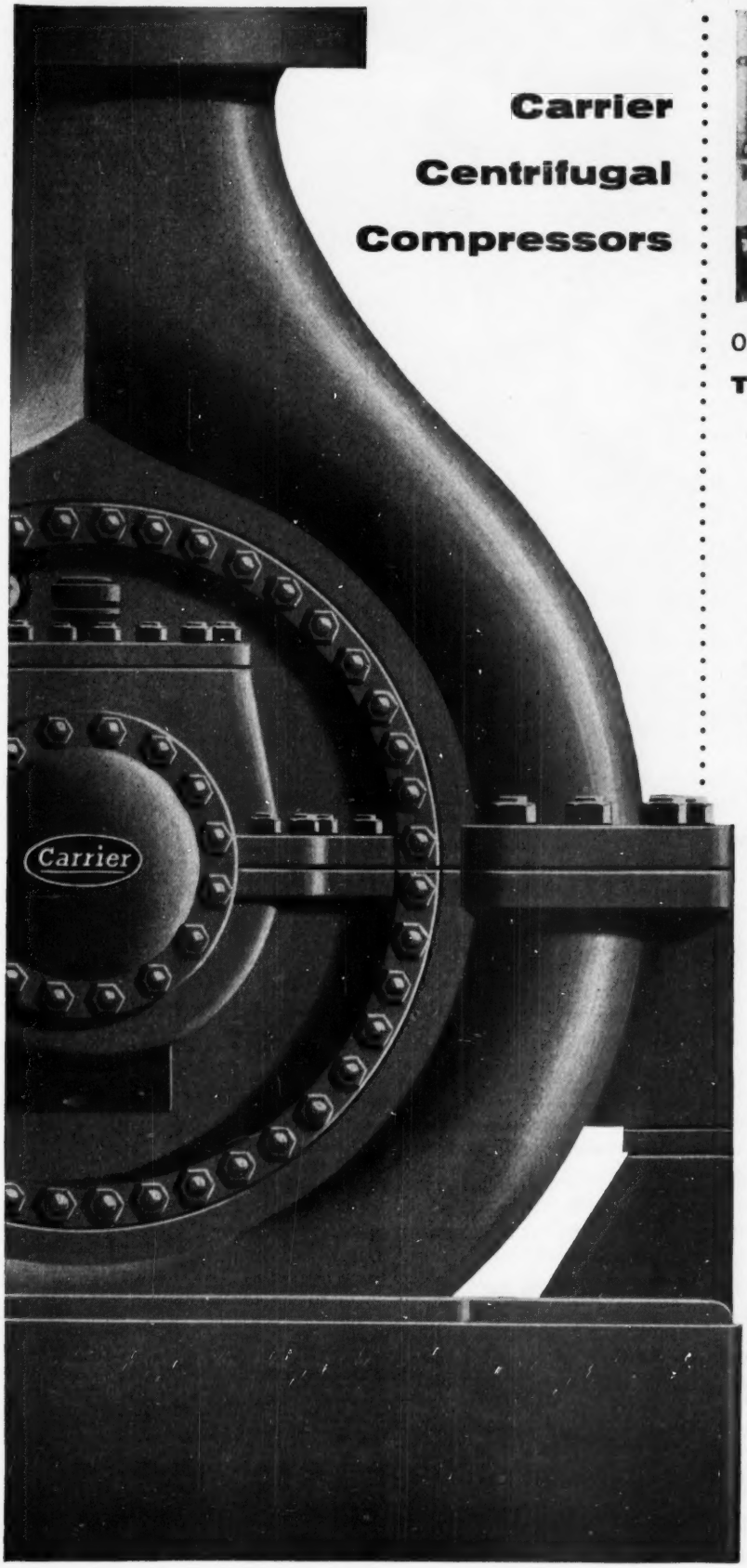
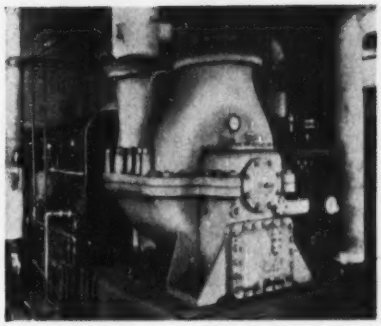


Carrier
Centrifugal
Compressors



on the job at

The Texas Company

This Carrier Centrifugal Compressor is one of two on the job at the Casper, Wyoming, fluid catalytic cracking unit of The Texas Company. The Texas Company has installed 14 other Carrier units at five other plants.

Carrier makes a complete line of centrifugals for air and gas compression and for refrigeration—up to 10,000 hp in a single unit. There are hundreds of these dependable, efficient Carrier machines on the job at dozens of chemical plants and oil refineries across the country—serving such companies as The Atlantic Refining Company, Tennessee Eastman Company, Sinclair Oil Corporation, Wyandotte Chemicals Corporation, Esso Standard Oil Company, Dow Chemical Company. May we assist *you?*

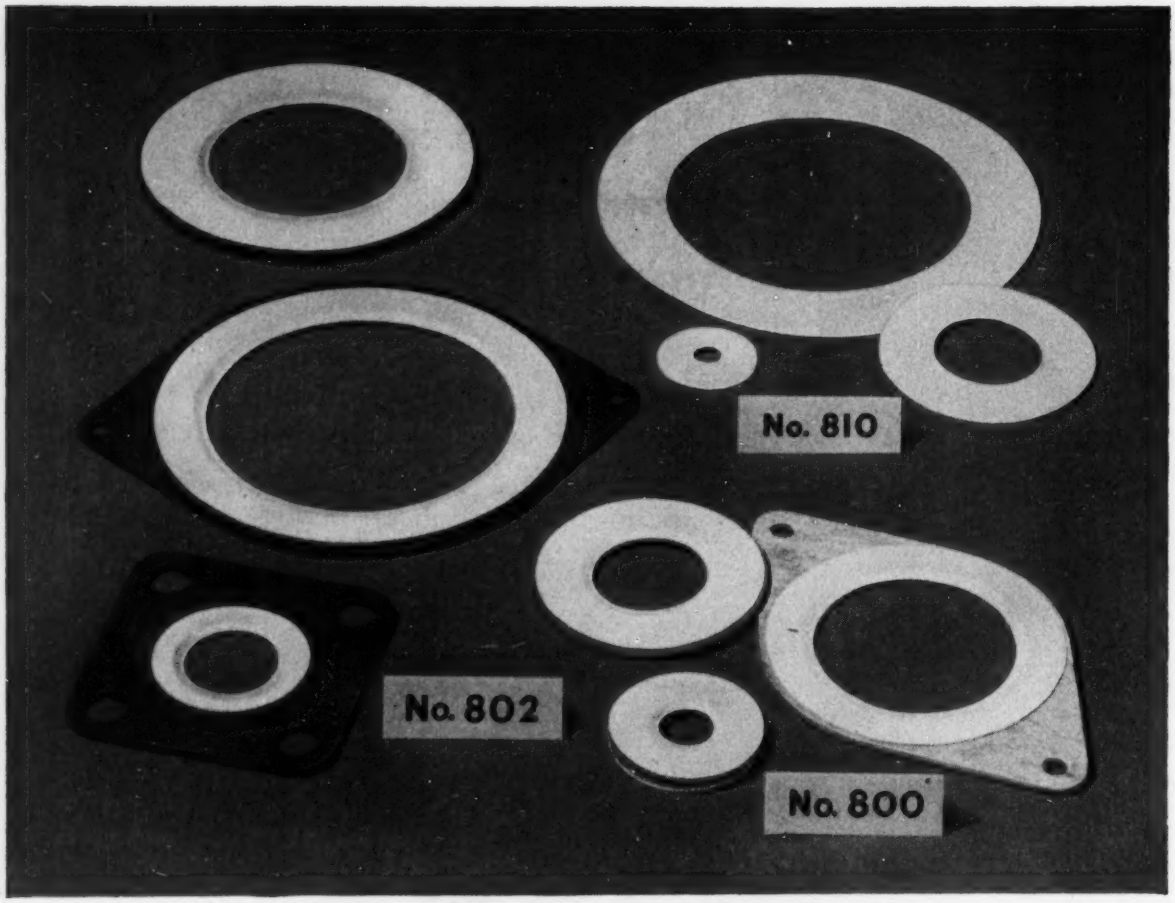
If you'd like a copy of our informative booklet,

"Centrifugal Compressors for Industry"

please call your nearest Carrier office. Or write direct to Carrier Corporation, Syracuse, New York.

Carrier

centrifugal compressors
refrigerating equipment



R/M Teflon* Gaskets are ideal for chemical use

Gaskets made of R/M TEFLON* are not affected by any industrial chemicals or acids. They are resilient and conform to rough and out-of-line flanges. They are ideal for use on glass lined reactor kettles; handholes and manholes; distillation columns; valves, flanges and tank covers; glass lined pipe flanges and nozzles. Two types are illustrated above: **R/M Nos. 800 and 802,** "French" or envelope gaskets for light flanges with low bolt loads, and **R/M No. 810,** solid rings for standard ring type flanges.

Protect your costly chemical equipment with R/M TEFLON Gaskets. Each one is carefully engineered to your performance requirements. See your R/M distributor for full details. The complete R/M TEFLON products line includes rods, sheets, tubes, tape, packings, gaskets, rings and irregular shapes.

**Du Pont's trade-mark for its tetrafluoroethylene resin*

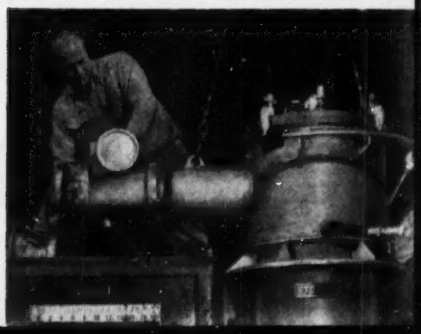
R/M MAKES A COMPLETE LINE OF PACKINGS AND GASKETS AND SELLS THEM ONLY THROUGH AUTHORIZED DISTRIBUTORS

R/M PACKINGS
RAYBESTOS-MANHATTAN, INC.
PACKING DIVISION, MANHEIM, PA.

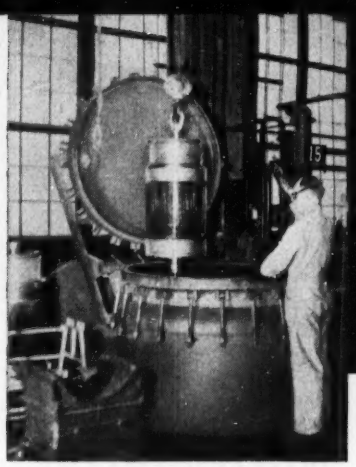
FACTORIES: Bridgeport, Conn.; Manheim, Pa.; No. Charleston, S.C.; Passaic, N.J.; Neenah, Wis.; Crawfordsville, Ind.; Peterborough, Ontario, Canada.

RAYBESTOS-MANHATTAN, INC., Packings • Asbestos Textiles • Industrial Rubber, Engineered Plastic, and Sintered Metal Products • Abrasive and Diamond Wheels • Rubber Covered Equipment • Brake Linings • Brake Blocks • Clutch Facings • Fan Belts • Radiator Hose • Bowling Balls

Operator transfers evacuated retort from heating to cooling station of Stokes Vacuum Annealing Furnace, designed and built for the processing, annealing and other heat treatment of titanium, zirconium, hafnium, copper and other metals.



One of the uses for the complete custom-built installation of Stokes vacuum freeze-drying equipment in Pitman-Moore Company's new million-dollar plant at Indianapolis, Ind. is to produce gamma globulin to combat poliomyelitis. One of the steps is drying the material from its frozen state. Operators are shown removing trays of gamma globulin from Stokes freeze-dryers. Temperatures are as low as 40° below zero F. during part of the freeze-drying cycle.



Diesel locomotive armature being removed, after impregnation, from Stokes high vacuum impregnating tank in the San Bernardino, Calif., plant of Atchison, Topeka & Santa Fe Railway. Electric motors for the Santa Fe's "Chief" and "Super Chief" develop such excessive heat that ordinary insulation would swell or burst, causing the rotors to "freeze" in the mounting. By impregnating these rotors with protective resins under high vacuum in Stokes impregnators, each turn of wire is held in place, motors operate without interruption.

Installation of Stokes Rotary Vacuum Dryers used by Metals Disintegrating Co., Berkeley, California, for drying of aluminum powder. Highly oxidizable materials can be handled without any danger of combustion or explosion when they are processed under vacuum.

Vacuum at Work

Diesel locomotive motors, paper and metals, medicines, electrical parts, toys . . . are but a few in a wide range of products which are processed in vacuum for the good of mankind and the profit of business.

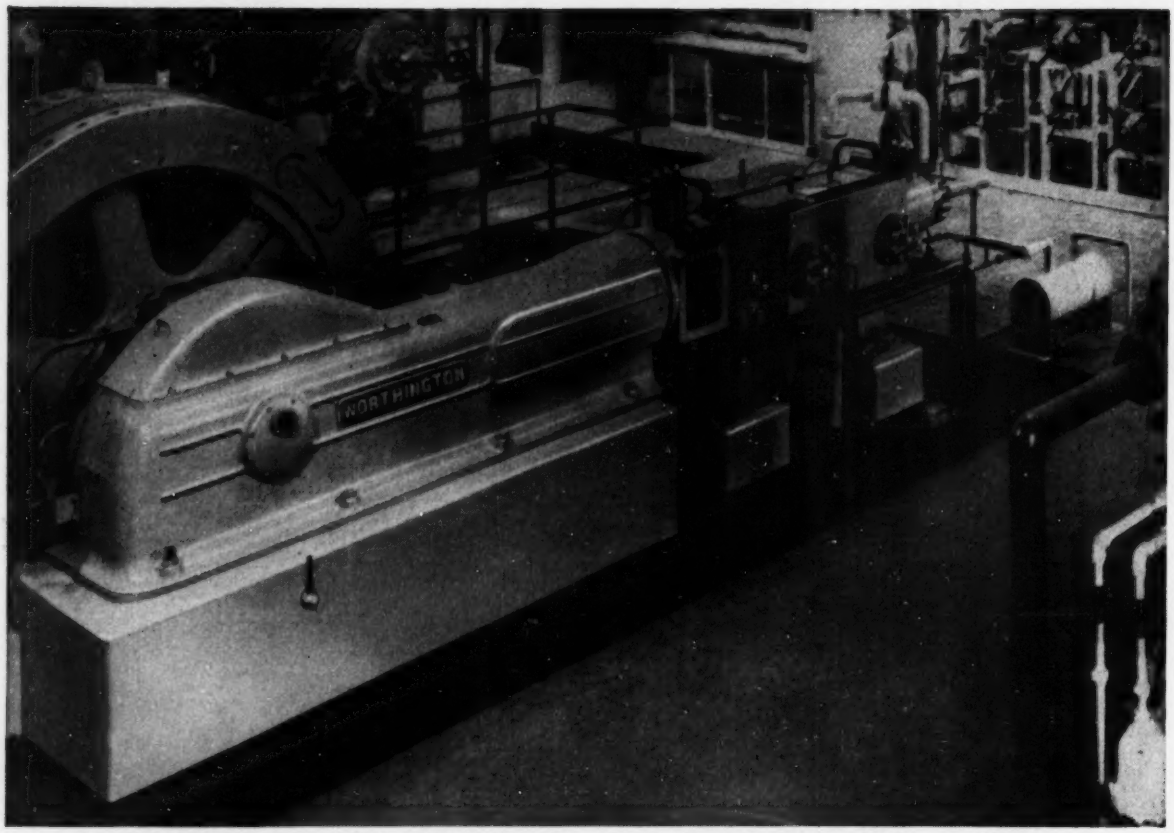
The application of vacuum engineering to industry is a major function with Stokes engineers. And naturally so, for it is at Stokes' that many of today's accepted procedures of vacuum processing had their inception during the last fifty years.

Stokes is FIRST in Vacuum . . . *first* in the design and manufacture of practical vacuum processing equipment . . . and Stokes engineers are available for consultation on opportunities to apply vacuum processing to your business.

F. J. STOKES MACHINE COMPANY, PHILADELPHIA 20, PA.

STOKES

STOKES MAKES: High Vacuum Equipment, Vacuum Pumps and Gages / Industrial Tabletting, Powder Metal and Plastics Molding Presses / Pharmaceutical Equipment



HIGH-PRESSURE WORTHINGTON RECIRCULATOR-COMPRESSORS help to manufacture synthetic ammonia at the Hooker Electrochemical Company in Tacoma, Washington. Gaseous nitrogen and hydrogen are compressed, circulated through a catalyst, and converted under maintained pressure and temperature into synthetic ammonia. The Chemical Construction Corporation of New York engineered this installation.

Hooker uses efficient Worthington unit in NH_3 synthesis

The Hooker Electrochemical Company in Tacoma needed a recirculator-compressor that would operate dependably and efficiently at the extremely high pressures involved in the manufacture of synthetic ammonia.

Worthington answered this need by supplying a Worthington High-pressure Recirculator-Compressor, with a discharge pressure of over 5000 psig. This was a routine operation for Worthington engineers, since they have furnished similar units on many previous occasions.

The compressor cylinder, complete with packing boxes, is a one-piece forging. The piston rod, piston and tail rod are also integrally forged. These features insure the accurate alignment essential to successful operation of high pressure equipment. And this alignment is maintained throughout years of operation.

This is another example of the way a manufacturer benefits by Worthington's skilled application engineering and the completeness of the Worthington line. Because Worthington manufactures compressors of every size and type, there's a Worthington machine that will exactly fit *your* needs. Get in touch with your nearest Worthington district office, or write to Worthington Corporation, Compressor Division, Section K.3.2, Buffalo 5, N. Y.

K.3.2

WORTHINGTON

Only Worthington Compressors give you Feather Valve Performance

Y-Types • Balanced Angle • Horizontal • Portable • Radial • Gas Engine Compressors

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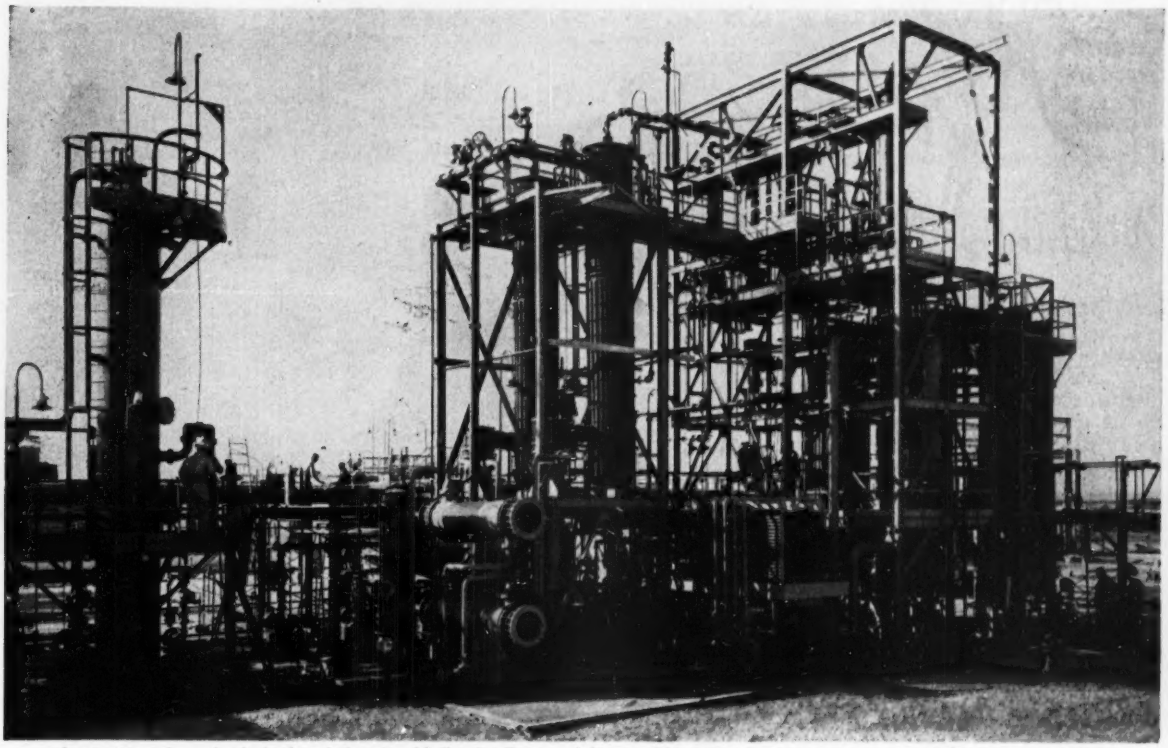
PIPING • VALVES • FITTINGS • PRESSURE PROCESS TANKS • ABSORBERS AND SCRUBBERS
HEAT EXCHANGERS • FUME DUCT • PUMPS • VACUUM JETS AND CONDENSERS



A recent petroleum chemicals plant designed and built primarily around the use of Haveg—a basic construction material that resists corrosion.

Petro-Chemical Corrosion has been Controlled!

Now for designers and engineers of petro-chemical plants there is an old and proven basic material of construction, borrowed from its 22 years of service in the chemical and metallurgical industries. It is Haveg, a plastic molded in the form of finished process equipment, or available for many types of field fabrication. Made from acid-digested asbestos and special thermosetting resins, Haveg enables you to go into a high range of process temperatures with complete safety and a proven history of outstanding performance.

Haveg has three great virtues. It is completely resistant to most corrosion. It lasts for years. It is amazingly versatile.

Not a coating or lining, Haveg gives resistance to corrosion through its entire mass, never allowing corrosives an opening wedge from cracks. It resists thermal shock, seldom requires insulation.

From steel-jacketed pressure process tanks down to the last piece of pipe, many of the petro-chemical processes can be completely contained and kept free from corrosion. Unnecessary maintenance, controls, headaches are avoided. Should plans or processes change, Haveg equipment can be machined and altered by your men, on the job. Accidental mechanical damage is easily repaired, using Haveg cement. Full chemical resistance is maintained.

If your job is fighting corrosion, get a helping hand from Haveg. Call the experienced sales engineer listed. Write for the 64-page illustrated Bulletin F-6 which contains size and chemical resistance charts, design specifications. Remember, Haveg is a logical answer to your design problems in handling petro-chemicals; in fact, in all process equipment that must handle corrosives.

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DETROIT 39 Kenwood 1-1785 • HOUSTON 4, Jackson 6840
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NEWARK 2, DELAWARE

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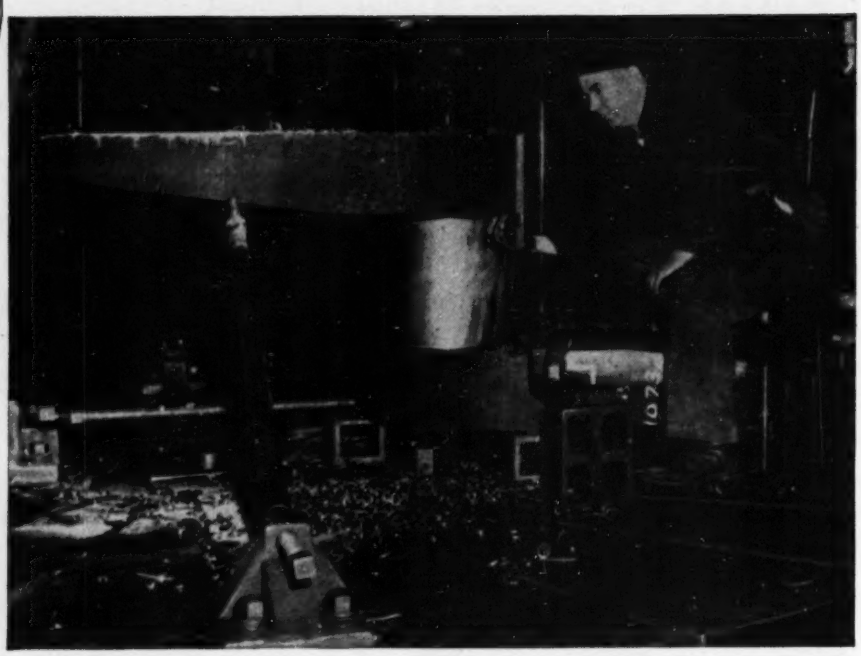
FACTORY: MARSHALLTON, DEL. • Wilmington 3-8884

A SUBSIDIARY OF CONTINENTAL-DIAMOND FIBRE CO.



The chips that talk...

To the native savage, whose tribe had no conception of a written language, the piece of wood on which the explorer scribbled a message became the wonderful "chip that talks."

The chips of metal that pour in silver drifts from the mighty machines in Sun Ship's Wetherill plant tell their stories, too. Those shown on the 14-foot boring mill tell part of the story of a fast, thorough repair job on ship-propulsion machinery. That job required lifting a 54-ton section of crankshaft from the ship to a 10 ft. x 50 ft. engine lathe, where it was checked for trueness and the journals machined. The crankpins were machined in a huge crankshaft machine. The boring mill operation shown was the facing of the webs of a new section which replaced one of the damaged sections of the crankshaft.

That's the kind of story the versatile men and machines at Sun Ship have been writing for decades . . . in building special machinery of every type for the varied industries that are building a greater America.

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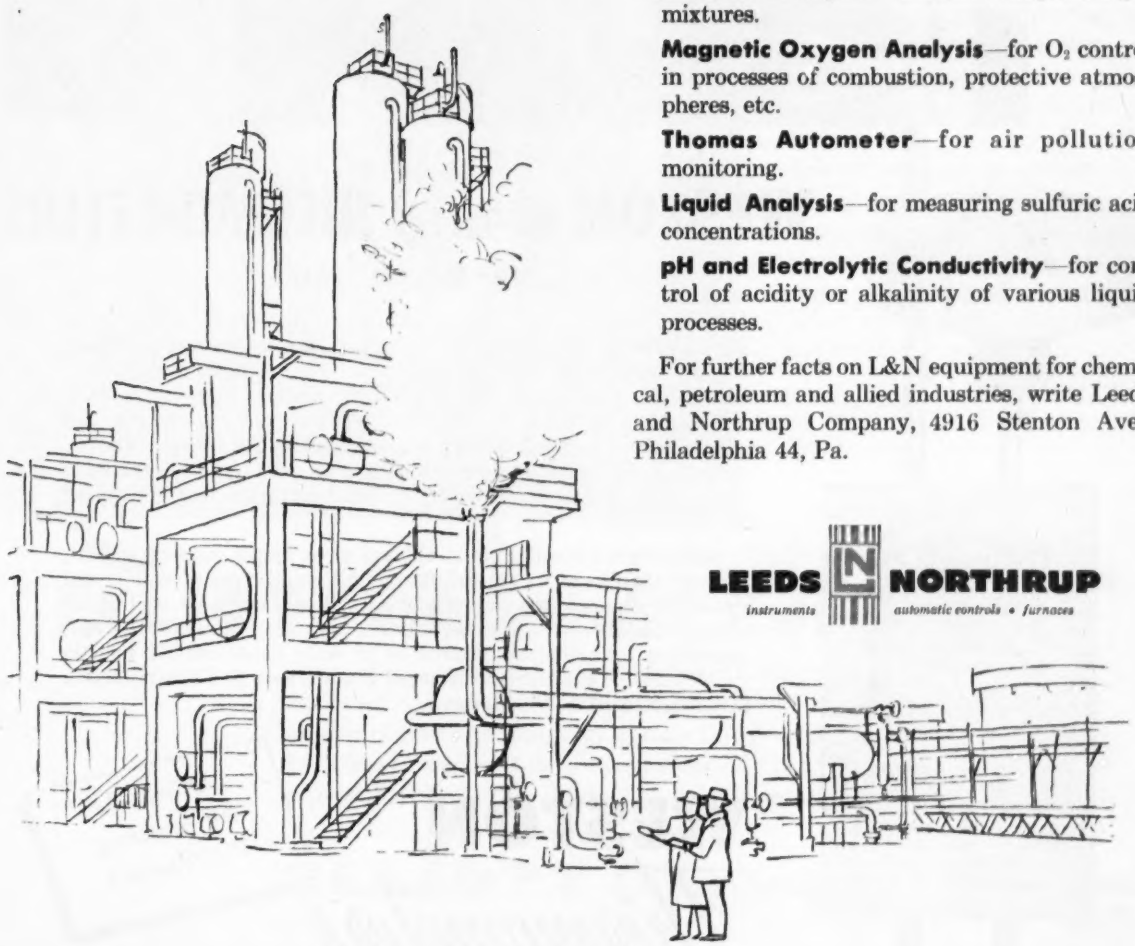
For further facts on L&N equipment for chemical, petroleum and allied industries, write Leeds and Northrup Company, 4916 Stenton Ave., Philadelphia 44, Pa.



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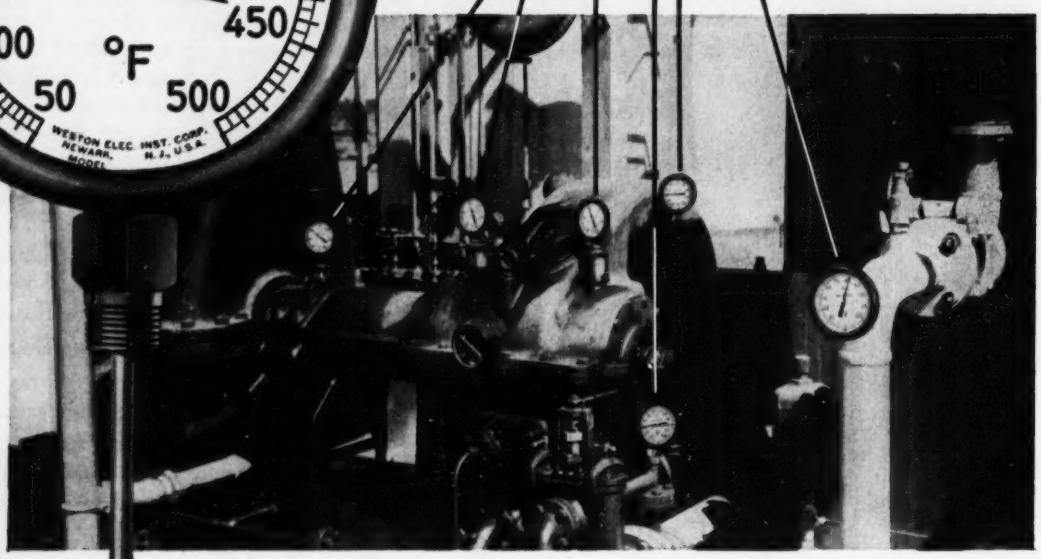

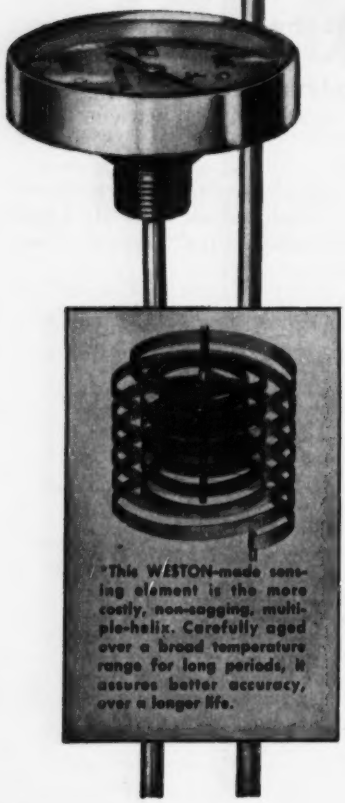
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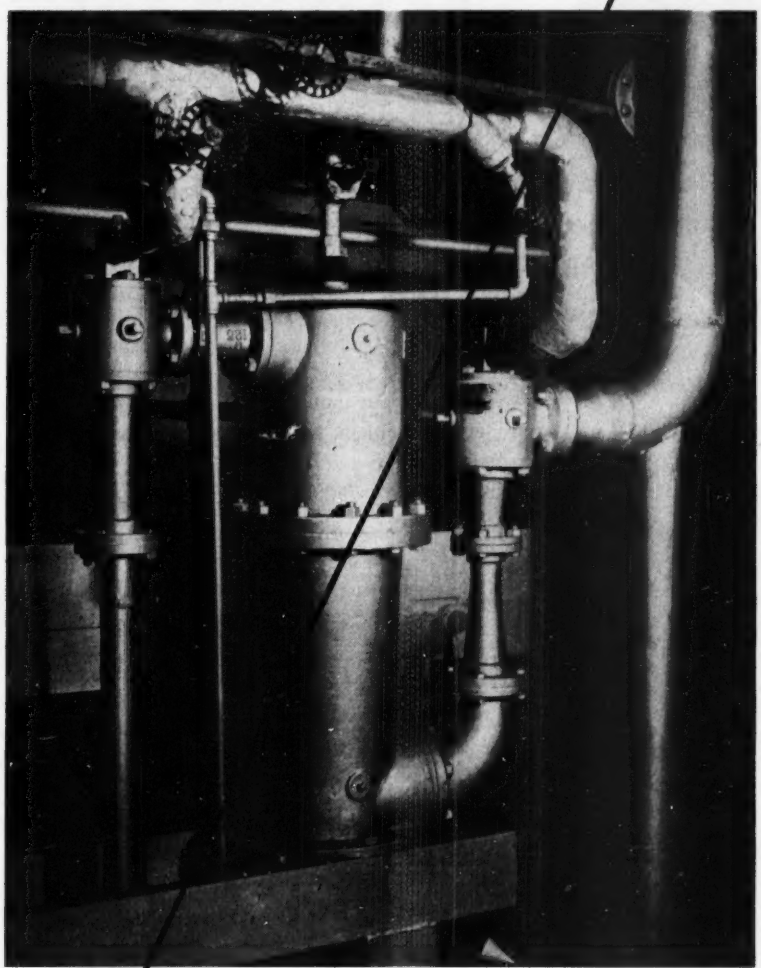
SHORT CUT TO LOW COST VACUUM

This is one of several Elliott two-stage steam jet ejectors in use in a Louisiana sugar mill.



You can go the long way 'round in pulling vacuum for evaporators and vacuum pans — using steam to drive a turbine or engine which in turn drives a piston vacuum pump. You can also pull vacuum by using the steam directly, in jet form, to pull the air and vapors, as in Elliott steam jet ejectors. That way you avoid many moving mechanical parts, all needing constant lubrication and occasional replacement due to natural wear.

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The leaching of uranium ores requires substantial quantities of sulfuric acid. To help meet this need, Chemico designed and supplied this plant in South Africa for an important producer of uranium. It is the first of five Chemico plants which are now operating or nearing completion in South Africa alone for this purpose.

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Chemico's service goes with its plants wherever they are installed. Even at this distant location, skilled Chemico engineers supervised the construction and initial operation of the plant and trained the operators until they were thoroughly familiar with its working.

Here is another example of Chemico's widespread activities, constantly enlarging the scope of its experience.

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ENCASED CLOSE-COUPLED PUMP

IS BEST SUITED TO MANY REFINERY AND FIELD PROCESSING APPLICATIONS

SPACE-SAVING AND COST-SAVING IN INSTALLATION . . .

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The vertical, multi-stage, turbine type construction of the Hydro-Line pump permits economical and quick installation of additional pump stages (bowl and impeller units) should future system demands exceed those of the installation for which the pump was initially installed. Further, removal to another location is expedient with Hydro-Line's type of construction.

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With ordinary pumps, available NPSH is frequently insufficient for optimum operation. The Peerless Hydro-Line, multi-stage vertical turbine pump is especially designed for low available NPSH conditions. It is ideal for condensate return service and for pumping petroleum hydrocarbons, refrigerant mixtures and dilute alcohols.

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Especially suited for pumping hydrocarbons, such as gasoline, butane, propane, hot oils, etc. hot or cold water, mild acids, bases, salt solutions.

CAPACITIES
Up to 5000 gpm

HEADS
Up to 1500 feet

TEMPERATURES
From 0°F to 400°F

PRESSURES
Working pressures to 500 psi.

DRIVES
As required, standard vertical, solidshaft, hollowshaft or explosion-proof motors; steam turbine.

SEALING CHAMBER
Peerless mechanical shaft seal standard construction or packing gland furnished as required.

MATERIALS
Cast iron bowls, bronze impellers, #416 stainless steel shaft standard; any special materials can be furnished on order to suit individual requirements.

WRITE FOR NEW BULLETIN—Use the coupon at right to obtain your copy of Peerless Bulletin No. B-1700, which describes and illustrates the successful and exacting design, construction and performance characteristics of the Hydro-Line pump.

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Cross section view illustrating the crushing action

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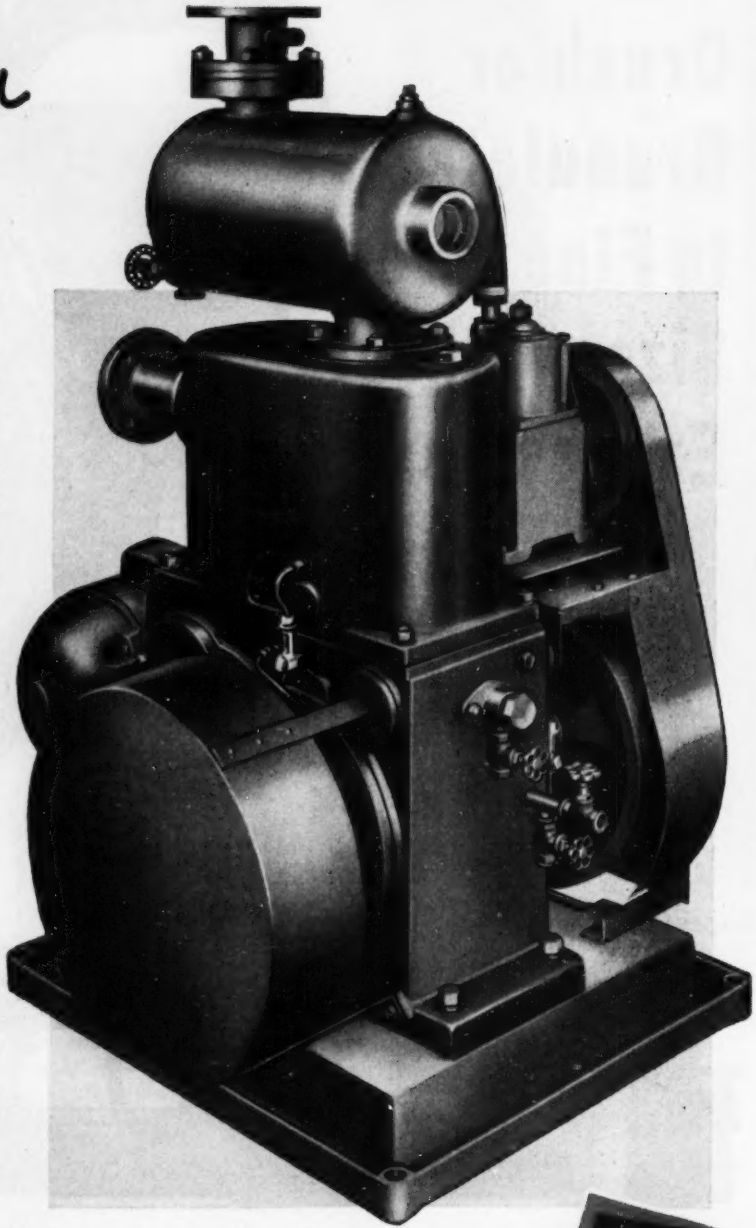
Shave Minutes Off Pump-Down Time

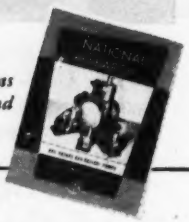
Experience proves NRC high vacuum Rotary Pumps pump down faster. Employing the revolutionary Gas Ballast principle, they're more efficient both mechanically and volumetrically especially at low pressures. They permit minimum blow back and leakage past the pumping members. Since vapors won't condense in this pump, fast pump down time is always maintained.

Dollars Off Your Pumping Costs

The efficiency of NRC Rotary Pumps makes for substantial savings. NRC's special inlet design screens out dust and foreign matter — protects pump parts from undue wear. Dynamic counter-balancing results in minimum vibration. Easier to service. More dependable to operate. Users report long life, low operating costs under the most adverse conditions.



Send today for new Bulletin explaining the Gas Ballast principle plus complete operating and construction data.



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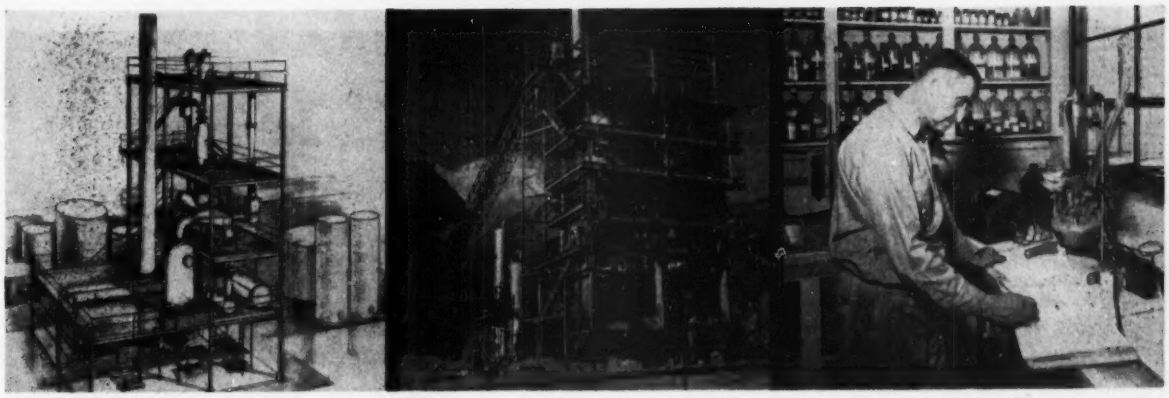


Vacuum distillation of fatty acids

The first plant using Shell Development Company's new heated Turbogrid trays, engineered and under construction by SWECO. Stainless steel process equipment fabricated by SWECO.

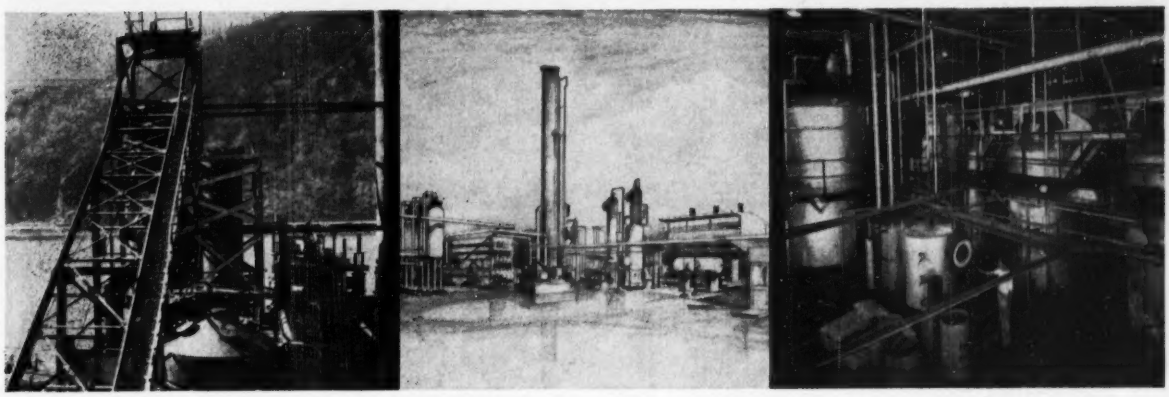
Oil Shale pilot plant

The first successful commercial-scale project for tapping the Nation's enormous oil shale resources. SWECO engineered and constructed. SWECO research in oil-shale processing continues.

Sulfur from low-grade deposits

SWECO metallurgists helped develop new process to obtain elemental sulfur from low-grade surface deposits. SWECO is designing and building first commercial plant.

Progress Report on Plants and Processes



Vital Manganese from slag piles

The first pilot plant to recover manganese from steel mill slag, constructed by SWECO. Blast furnace and converters use complex, high-temperature, pyro-metallurgical process.

Naphtha plant and reformer

Complete 2500 BPD naphtha fractionating plant and 1000 BPD reformer (UOP process), engineered and constructed by SWECO for production of specialty solvents and high octane gasoline.

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One of many plants engineered and constructed by SWECO for the removal and refining of crude oils from oleaginous seeds. Stainless steel and alloy process equipment SWECO fabricated.

SWECO engineers and constructors are serving basic process industries throughout the world in (1) flow-sheet development and economic surveys—(2) plant design, engineering and construction—(3) design, manufacture, procurement and installation of process equipment. These projects are typical of SWECO's way of doing things—*Right . . . and right on time.*

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Custom fabrication of all types of steel and special alloy vessels for the process industries.

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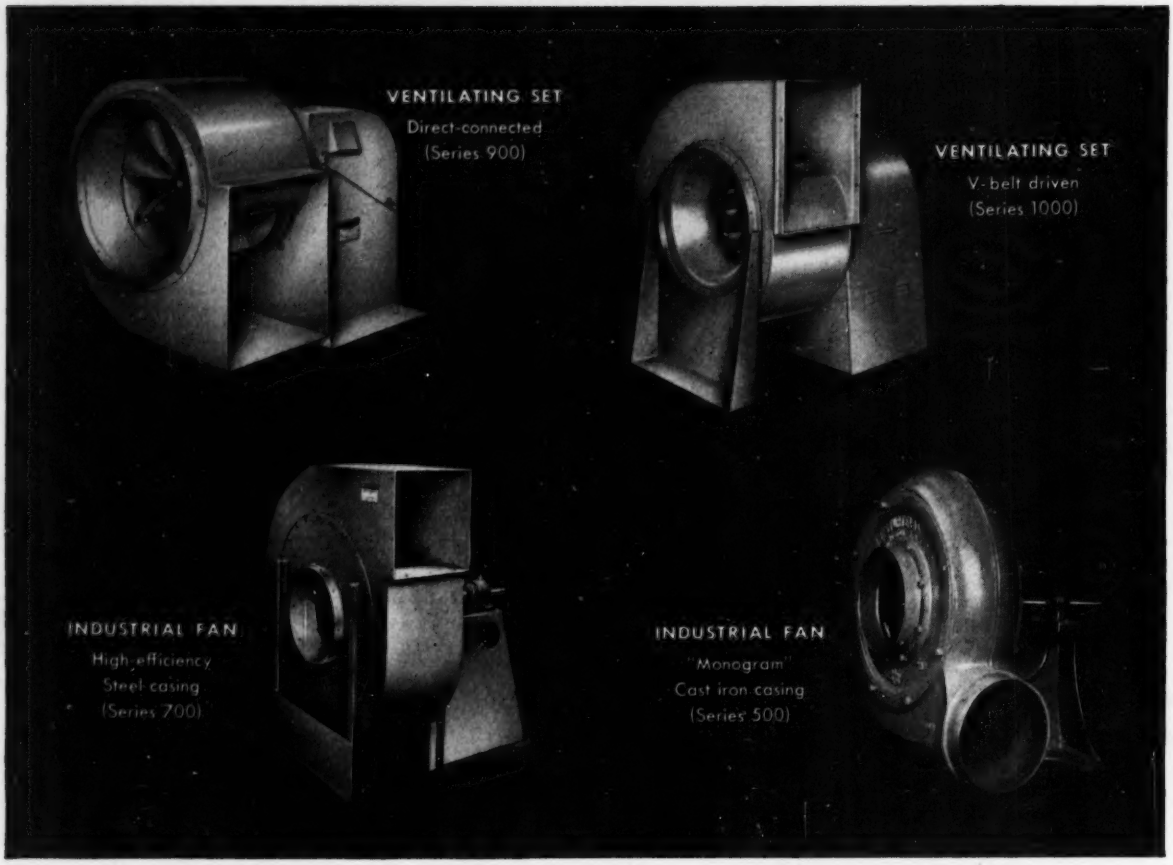

These Westinghouse Fans Help You Increase Production . . . Employee Efficiency

Whatever your air handling problem . . . smoke, fumes, vapor, dust, wood shavings, granular material or ventilating . . . these Westinghouse fans are designed to handle or remove them . . . efficiently and economically.

INDUSTRIAL FANS (SERIES 700) . . . for dust collecting and conveying at high pressure. Wide range of capacities. Three types of wheels in 11 sizes.

1. Air Handling Wheel . . . particularly adaptable for general air handling and exhaust systems in removal of smoke, fumes and gases.

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INDUSTRIAL FANS (SERIES 500—MONOGRAM) . . . ruggedly built, with cast iron casing. For use as a blower or exhaust or for dust control, collecting and conveying waste or raw materials, supplying air for furnace blast, drying, etc. Provides long, trouble-free service at low cost under severest operating conditions. In 10 sizes with wide range of capacity.

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SERIES 1000 VENTILATING SETS . . . V-belt driven, self-contained. Install indoors or outdoors in a wide variety of heating, ventilating or air conditioning applications. Twelve sizes from 9" to 30" wheel diameters.

These rugged, powerful Westinghouse fans provide the most economical solution to your specific air handling problem. And Westinghouse fans offer a *single equipment warranty* with undivided responsibility . . . an *exclusive* Westinghouse-Sturtevant feature. Get the facts today on the fan built for *your* need from your nearest Westinghouse-Sturtevant office. Or write: Westinghouse Electric Corporation, Sturtevant Division, Hyde Park, Boston 36, Mass.

WESTINGHOUSE AIR HANDLING

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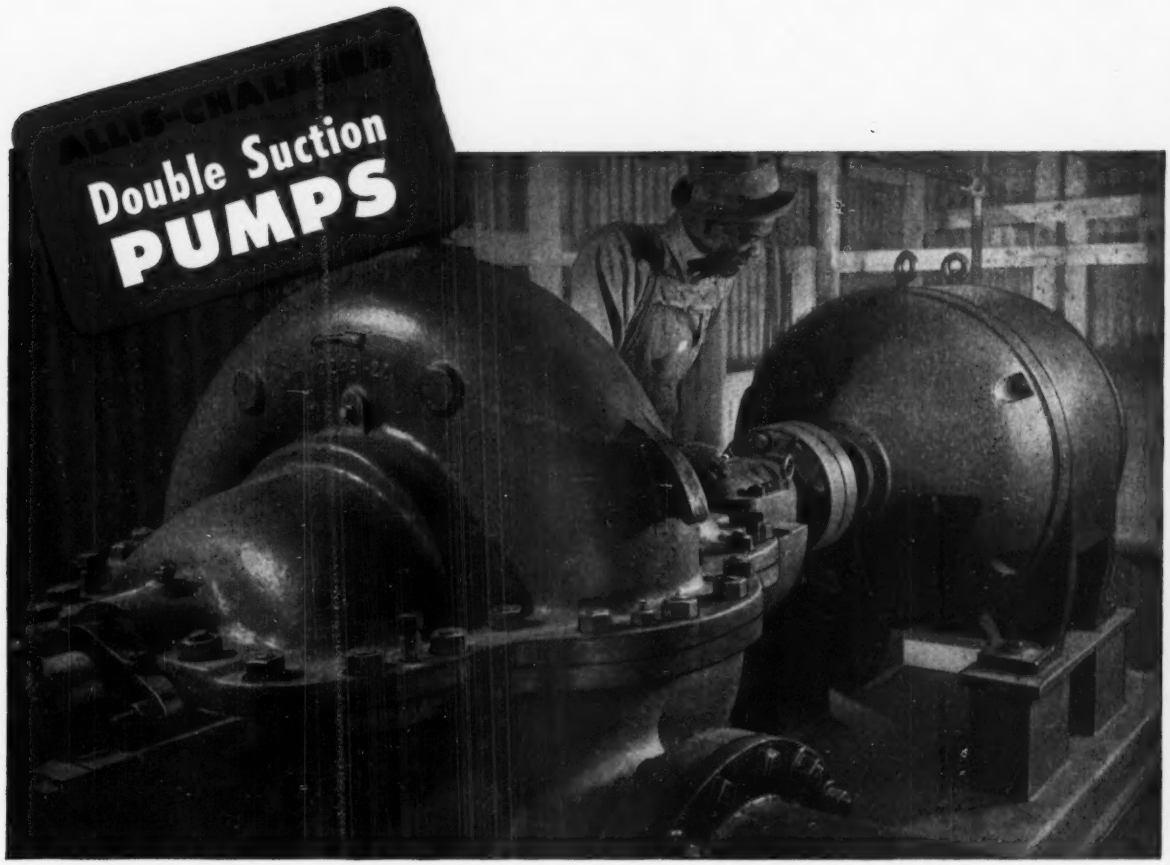

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FOR ALL GENERAL USES AND MANY SPECAL PROCESS APPLICATIONS, Allis-Chalmers double suction pumps are built with that extra measure of strength and ruggedness that assures you long life and low maintenance.

Every Allis-Chalmers double suction pump is carefully tested on the most modern electronically controlled pump testing equipment in the industry. Each installation is individually engineered by men whose experience in thousands of pump installations will give exactly the right pump for your needs.

Whatever your pumping problem, call your nearby Allis-Chalmers Authorized Dealer or District Office. Or write Allis-Chalmers, Milwaukee 1, Wisconsin, for Bulletin 08B6146.

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CONTROL — Manual, magnetic and combination starters; push button stations and components for complete control systems.

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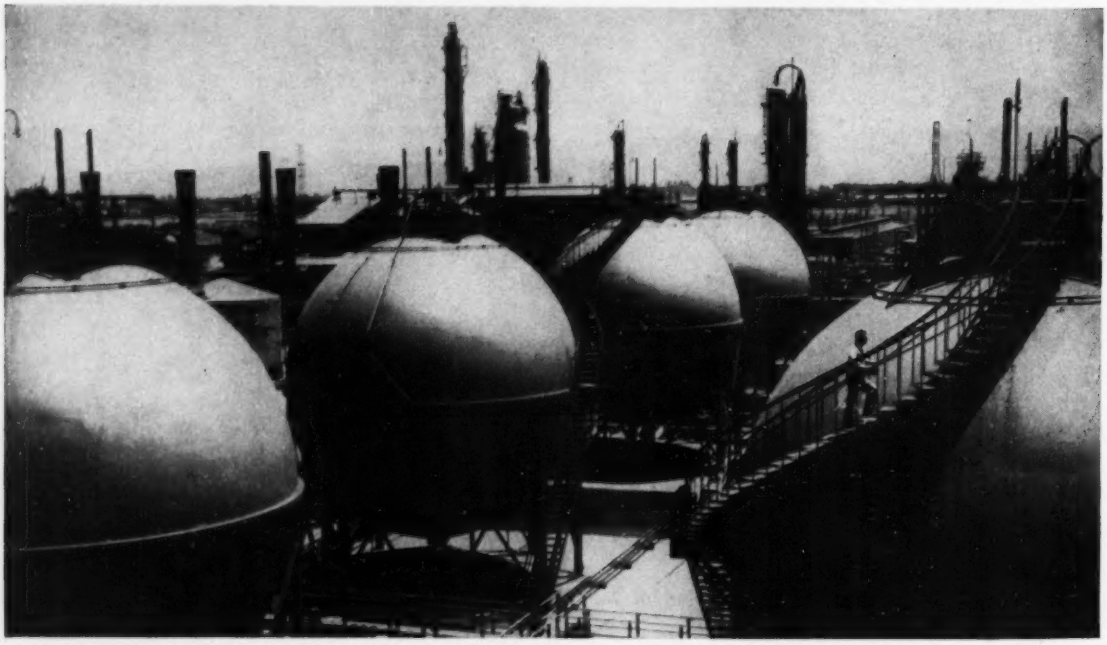


BECAUSE OF ACTIVE DEMAND for butadiene, these Hortonspheres are being put to full use. Here's the story of . . .

How to Make Butadiene

A CHEMICAL ENGINEERING PICTURED FLOWSHEET

- **From butylene to butadiene, that's the process used by Shell.**
- **Extractive distillation is one of the process highlights.**

There are three key steps in the Shell Chemical operated, government owned, butadiene plant at Torrance, Calif.

One—extractive distillation to purify butylene feed. Two—catalytic dehydrogenation of butylene to butadiene. Three—continuous countercurrent extraction with cuprous ammonium acetate.

Demand for butadiene has been increasing rapidly in the last few years. More and more it is finding its way into plastics, chemical synthesis, synthetic rubbers. And the recent offer for sale (by the Rubber Producing Facilities Disposal Commission) of the government plants, has been a big factor in the great interest shown this versatile chemical building block.

The Torrance plant is one of the units up for sale. A plant capable of producing 61 thousand tons of butadiene per year, it uses an up-to-date, proved process, starting with a butane-butylene stream. The flowsheet shows a typical operation.

▶ **Feed Purification**—Crude butane-butylene feed (from refinery C_4's or butane dehydrogenation) is first processed in an isobutylene removal unit. Here isobutylene is absorbed in H_2SO_4, polymerized at 200 F, and separated in a stripping column. Acid is recycled. Recovered butylene is further treated by the Shell extractive distillation process to remove butanes.

▶ **Butylene to Butadiene**—Butylene next flows into a catalytic dehydrogenation unit. This consists of two trains, each made up of a butylene heater, steam generator, superheater and pair of reactors.

Butylene vaporizes, mixes with steam in a heater, and is further diluted with superheated steam just before entering the reactors. With the aid of the auto-regenerative SHELL 205 (promoted iron oxide) catalyst, butylene converts to butadiene.

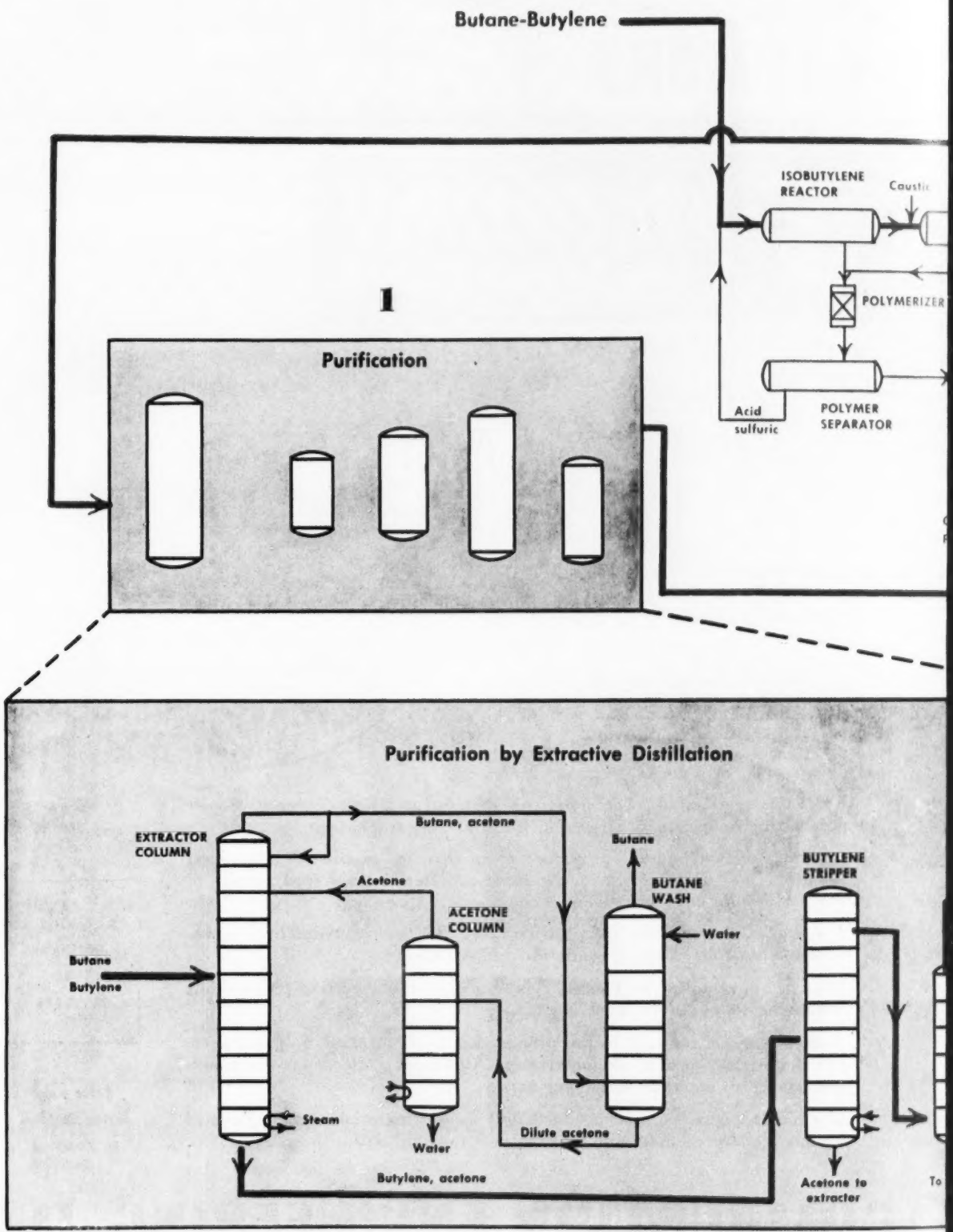
▶ **More Purification**—Since the reaction is not 100% selective, some light and heavy gases are produced.

Gases plus steam are quenched in an oil stripper scrubber—where heavy polymers are taken out. The vapors from the scrubber are cooled, compressed and partially liquefied.

Non-condensed gases pass to an absorber, where H_2, CH_4 and C_2H_6 are released. The liquid portion is fractionated, removing C_4's and lighter, C_5's and heavier.

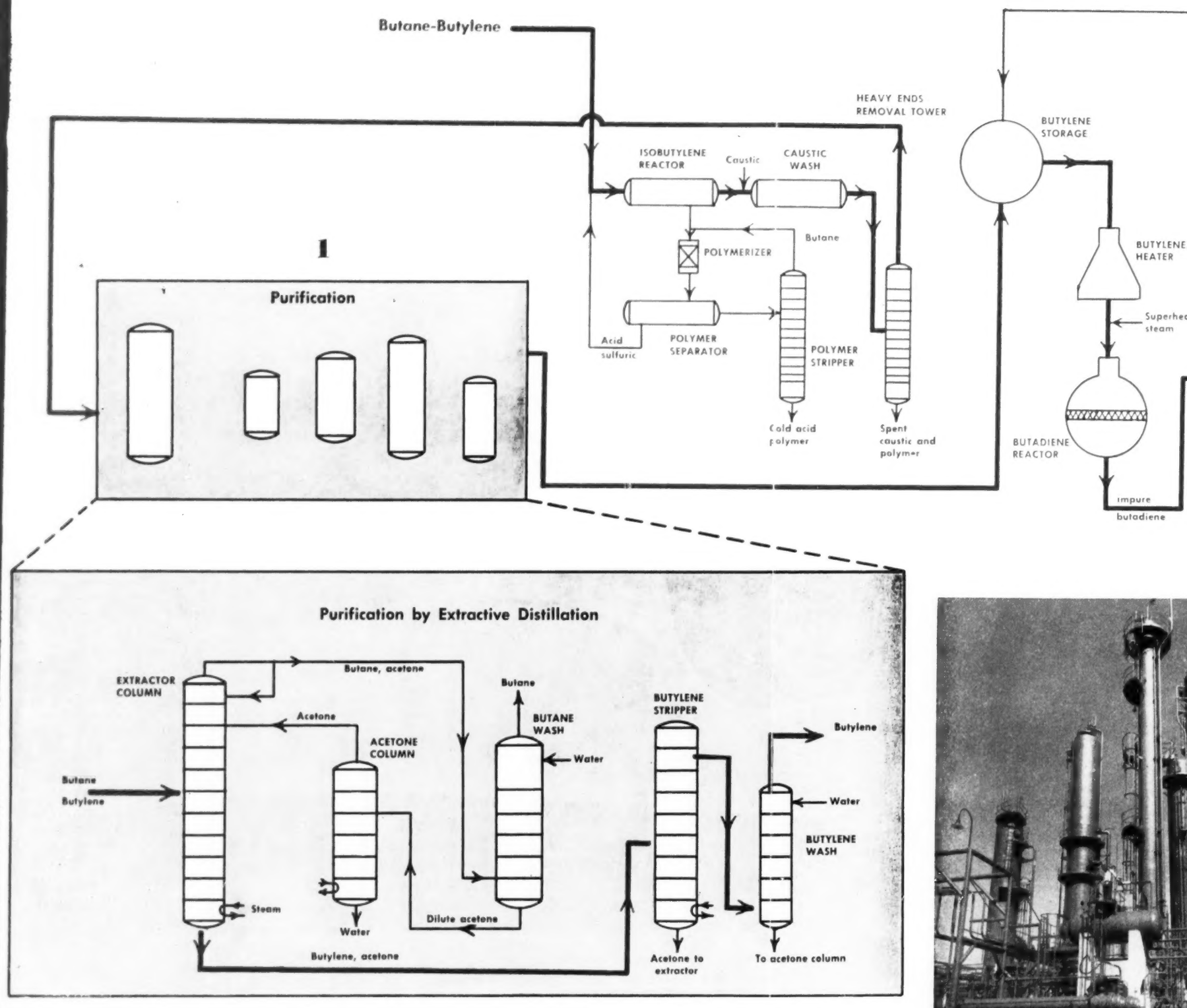
▶ **Continuous Extraction**—Next, the butadiene goes to a series of 12 mixer-settler extractors, for continuous countercurrent extraction. This is accomplished with a refrigerated (10 F.) aqueous cuprous ammonium acetate (CAA) solution (a Std. Oil of N. J. process).

Raffinate from the extraction flows back to the dehydrogenation reactor. Product butadiene (98%), is stripped from the CAA solution in a desorber.



Due to the close boiling points of butane and butylene, separation by a simple fractionation is not practicable. The butane must be removed, however, from butylene, since the catalytic dehydrogenation step (a Standard Oil of N. J. patent) depends on a pure butylene feed to catalytic reaction vessels.

What Shell does is add a third component—aqueous acetone—to the butane-butylene. In the acetone-hydrocarbon mixture the butane v.p. is enhanced—making a separation possible. Butane comes out as overhead from the tillation column. Bottom aqueous acetone and but stripped in a column; the then water washed for ace



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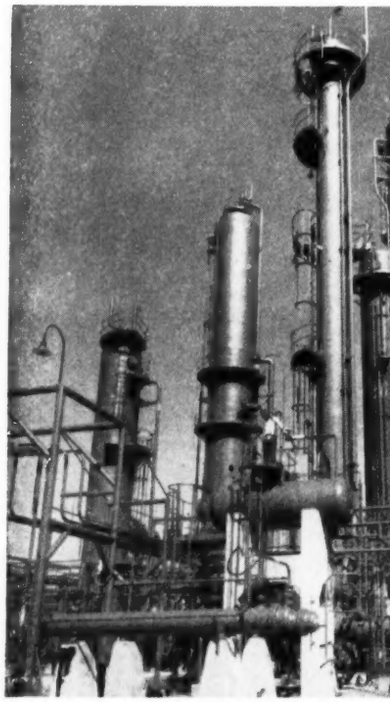
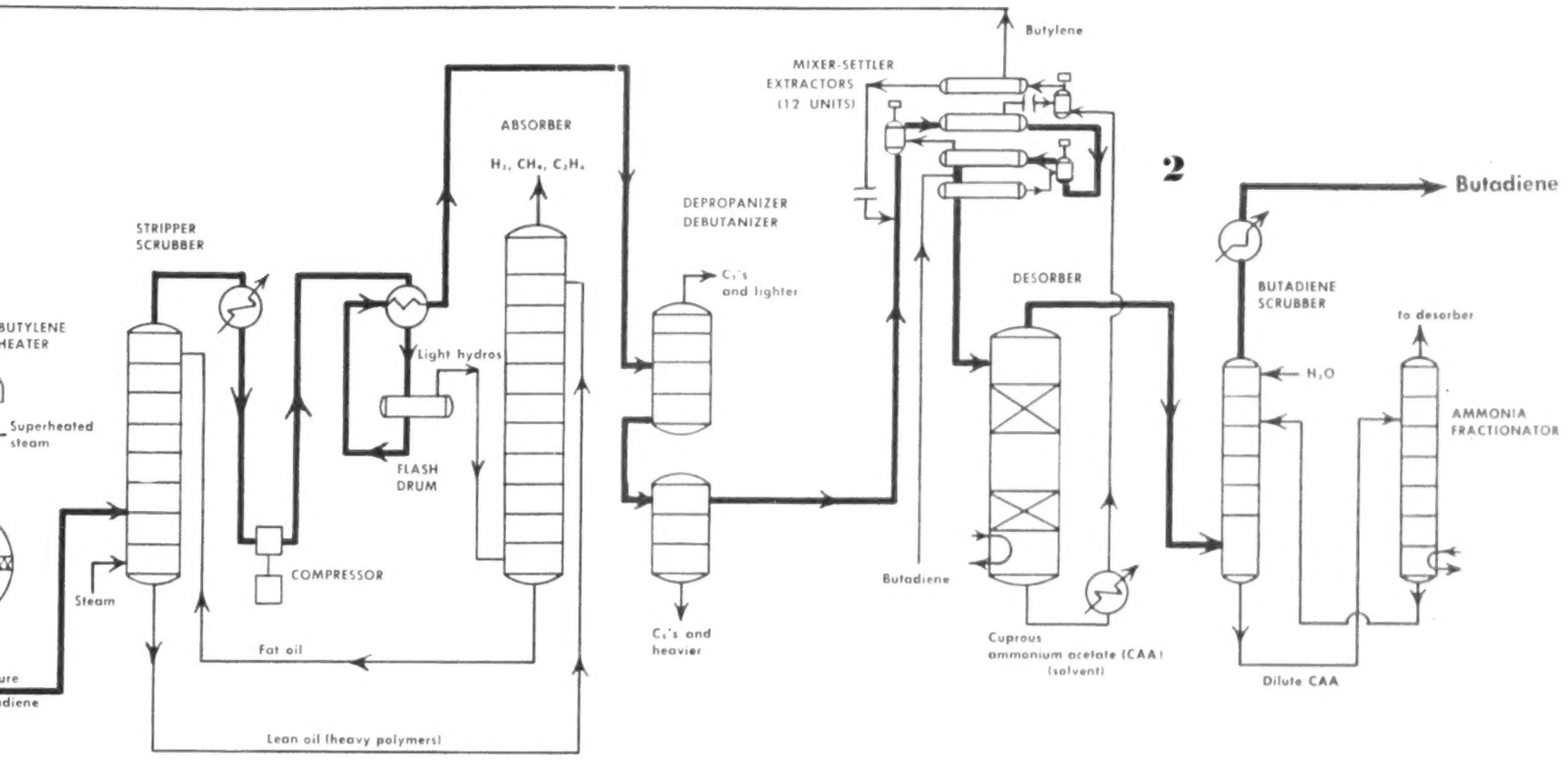
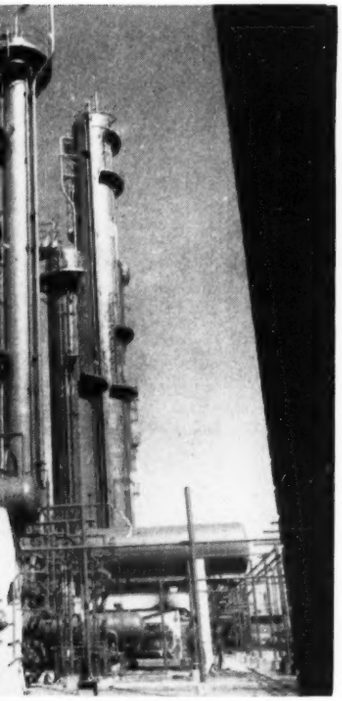
What Shell does is add a third component—aqueous acetone—to the butane-butylene. In the acetone-hydrocarbon mixture the butane v.p. is enhanced—making a separation possible. Butane comes out as overhead from the 71-plate extractive distillation column. Bottom product is a mixture of aqueous acetone and butylene. This mixture is stripped in a column; the butylene top product is then water washed for acetone recovery.

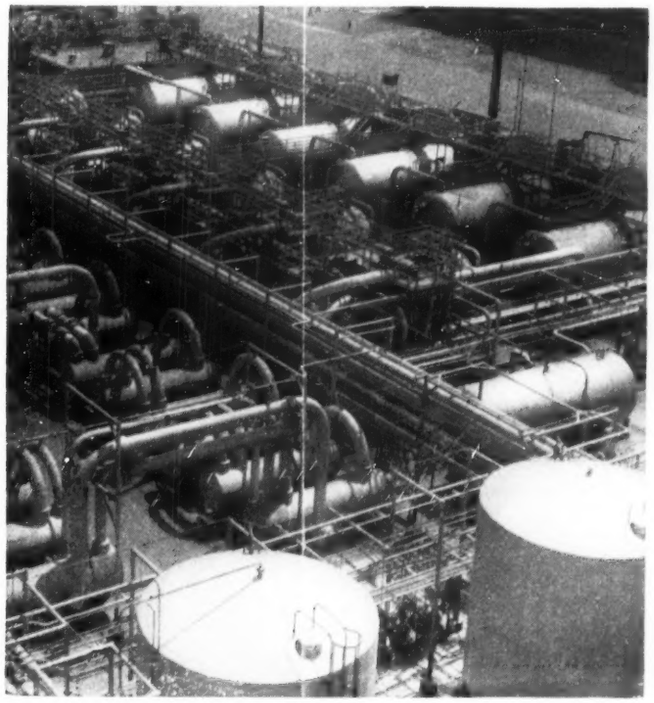


1 EXTRACTIVE DISTILLATION unit, the background. After this—butylene de





ON unit, with the extraction column in tylene dehydrogenation.

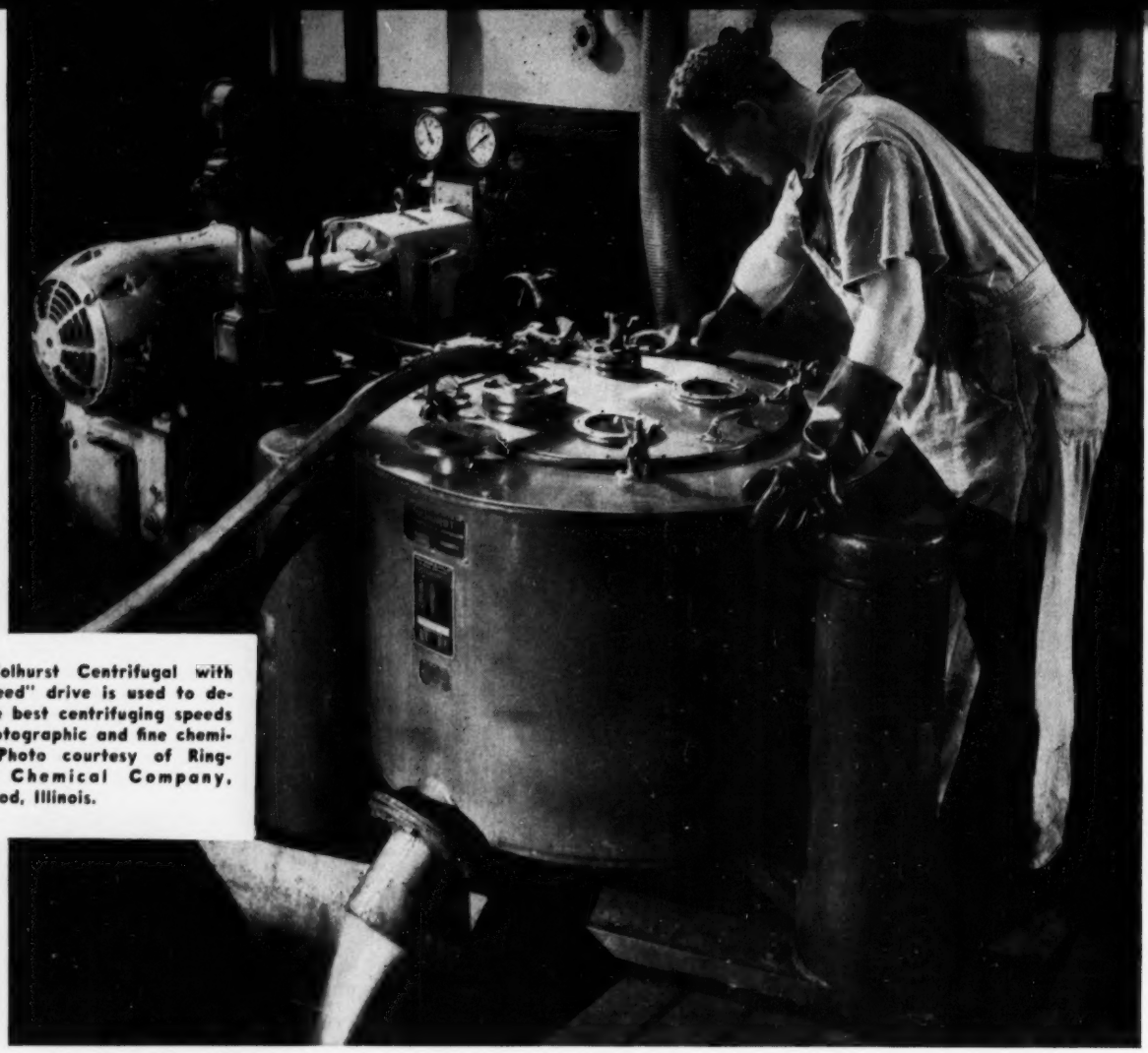


2 MIXER-SETTLER EXTRACTORS. Butadiene is removed from C_4 liquid by extraction with cuprous ammonium acetate solution.

Important Process Data

	Temperature, F Top		Bottom	Pressure Psig
Extractor column	138		247	100
Butadiene reactor	1,300		450	10
Stripper scrubber	220		285	2
Absorber	140		143	100
Mixer-settlers	10	to	35	30
Desorber	78		180	10
Butadiene scrubber	70		70	12

Per Ton of Butadiene	
Sulfuric acid	7.3 lb.
Acetone	12.1 lb.
Caustic soda	9.5 lb.
Catalyst	2.0 lb.
Copper	3.6 lb.
Ammonia	13.5 lb.
Acetic acid	4.3 lb.
Butylene	2,760 lb.
Electricity	415 kwh.
Natural gas	43 MCF
Steam	47 M lb.



This Tolhurst Centrifugal with "all-speed" drive is used to determine best centrifuging speeds for photographic and fine chemicals. Photo courtesy of Ringwood Chemical Company, Ringwood, Illinois.

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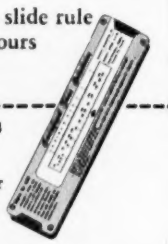

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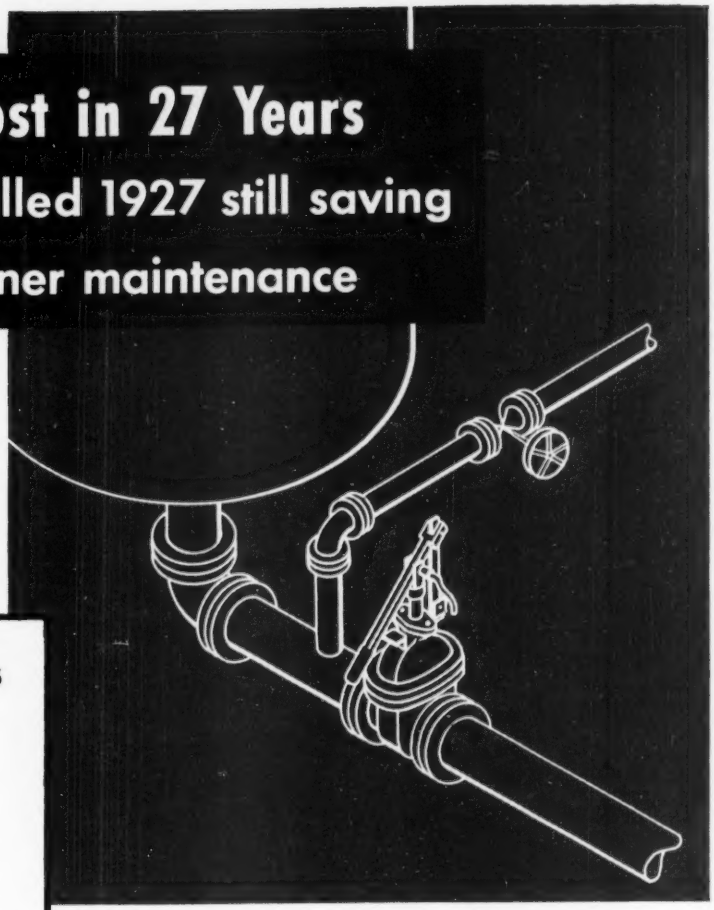


The Installation

At Phoenix Manufacturing Company, Joliet, Illinois, steel and rubber products plant. Original installation of 6-inch Crane quick-opening iron gate valve on flush-out line from water treating tank in soda ash-lime softener system.

Valve Service Ratings

SUITABILITY: Never failed

FEATURES: Rugged, easy-to-service design

MAINTENANCE COST: Zero

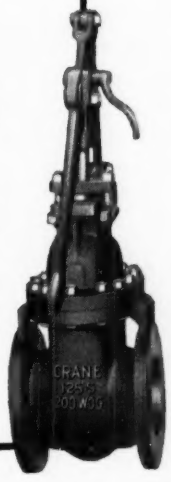
SERVICE LIFE: 27 years—still on job

OPERATING RESULTS: Lower cost water treating

AVAILABILITY: Crane catalog item—Current No. 471

The Valve

Further improved inside and out in many ways since 1927, modern Crane Iron Body Gate Valves keep making these performance records. Quick-opening design No. 471 shown, is but one member of this big, complete in size and pattern family. Includes OS&Y and inside screw valves; all iron and brass trim; screwed, flanged, and hub ends. Whatever your need, Crane lists it in your No. 53 catalog—or ask your Crane Representative.



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With each operation—2 or 3 times daily—more than 27 years—this Crane valve has demonstrated the thrift of a quality-buying policy.

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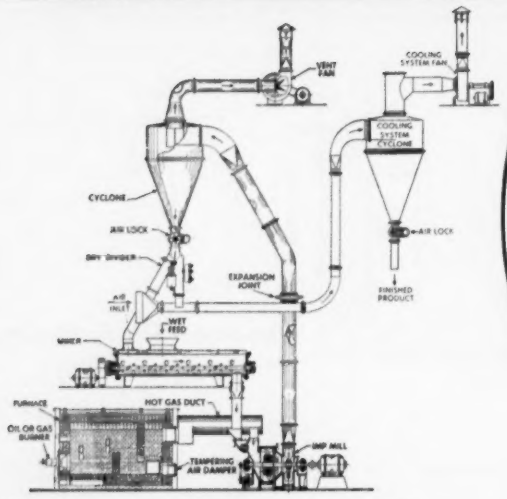
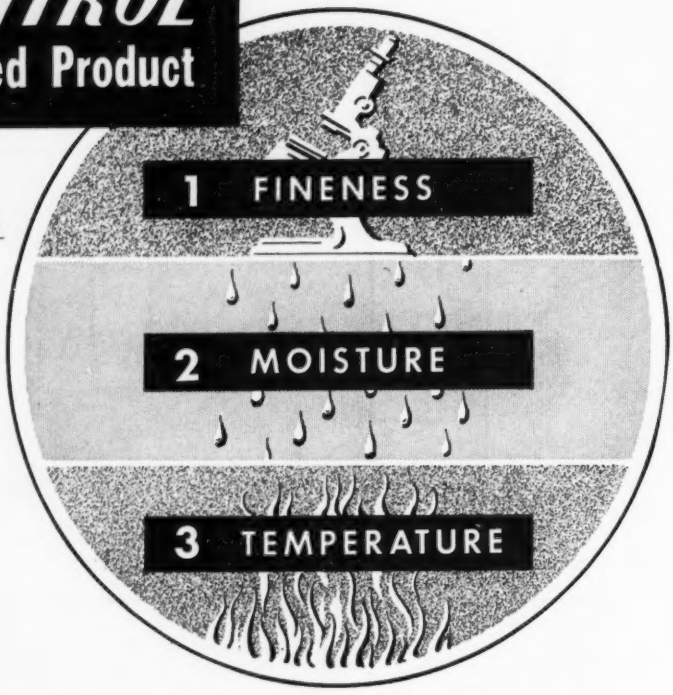


Typical flow sheet of Raymond Imp Mill with Flash Drying and Cooling System



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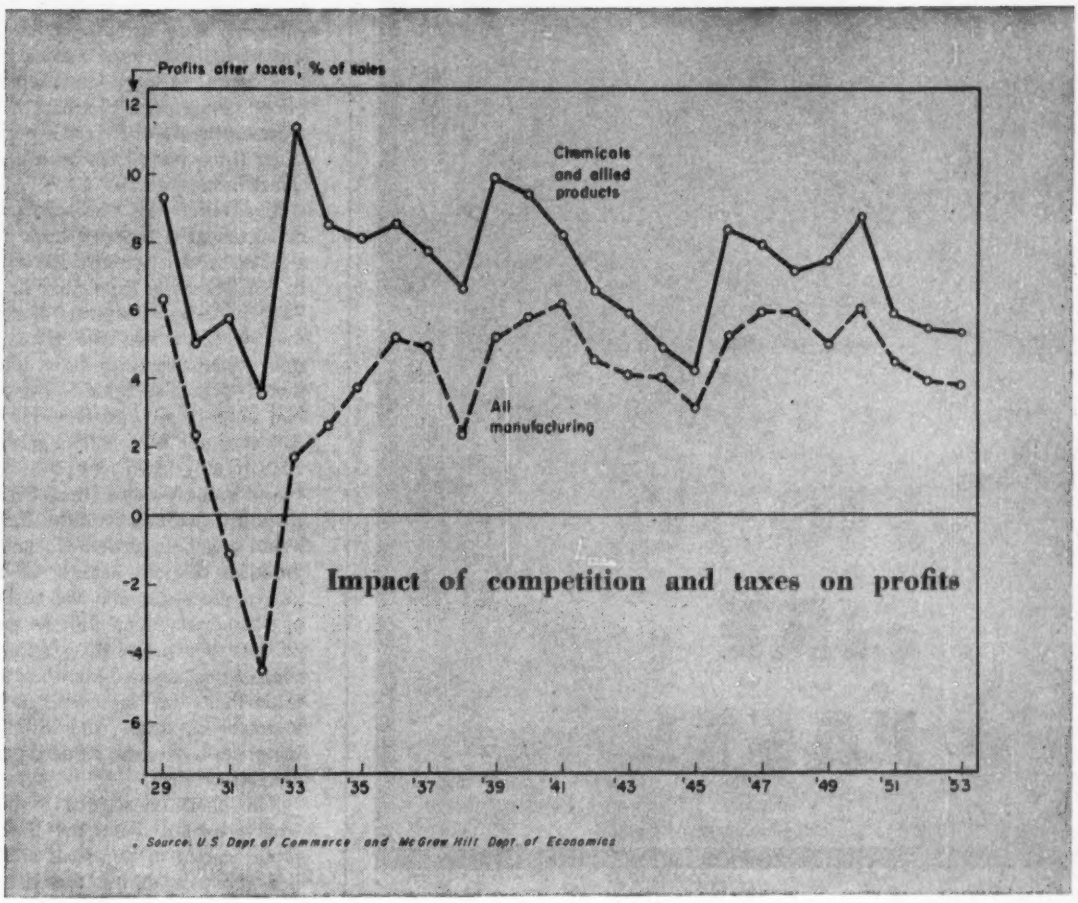

How an Investor Looks at Chemicals

Just because you're "diversifying" in a "growth industry" is no guarantee of lush profits. Actually, unless you're careful, it could be your downfall.

William H. Chartener, McGraw-Hill Dept. of Economics

An important consequence of rapid growth is often squeezed profit margins. Many chemical companies are now learning this lesson first-hand. Going into production of petrochemicals, for example, to draw a share of an expanding market, is no sure road to big profits. It may merely involve you in nervous price competition.

This is the conclusion drawn in a recent study by Richard P. Windisch, a specialist in chemical securities with W. E. Burnet & Co., New York. From an investor's standpoint, there is no assurance that a stock will pay off just because a company happens to be in a growth industry. For chemical makers, there are poignant lessons in the effects of competition on flourishing business.

► **Success Breeds Competition**—It's hard to keep a good spot to yourself. This is just as true in the chemical business as it is in trout fishing. A lucrative chemical market is certain to attract rival manufacturers, and even patented or secret processes don't always afford full protection. (*Continued*)

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ECONOMICS . . .

Competition in research, engineering and marketing, to create better products, make them more efficiently and distribute them more widely, has long been a force putting heavy pressure on chemical prices. Some price cuts have been spectacular, especially for a period when rising costs have been a national headache.

Since 1920 the wholesale price of acetone has dropped from 21¢ a lb. to 8¢, borax from $165 a ton to $35.75, rayon from $6 a lb. to 78¢. In only a few years of commercial production the prices of some pharmaceuticals have plummeted—penicillin from $50 a million units in 1944 to only 8½¢ today, cortisone from $200 a gram in 1949 to only $3.75 now.

► **And Profit Margins Drop**—Part of these price reductions undoubtedly would have been made by the initial producers merely because of improved processing and the benefits of mass production. But the gradual loss of a protected position as competitors acquired knowhow and made their own improvements has hastened the drop. And with falling prices have come reduced profit margins on sales.

The chart on page 313 shows what's happened to the average profit margin in chemicals and allied products during the last 25 years. The chemical industry's profits after taxes in 1929 were 9.3% of sales and reached 11.4% in 1933. Since World War II profits after taxes have exceeded 8% of sales only twice and in the last three years the figure has been only 5-6%.

Excess profits taxes during and after World War II pulled down post-tax margins in chemicals. A marked improvement is likely this year with the expiration of this tax. Nevertheless, the chart indicates a narrowing of the spread between profit margins in chemicals and those in manufacturing as a whole since the 1930's. Also, other industries besides chemicals will benefit from the end of the excess profits tax.

► **But Dollars Are Up**—Shrinking profit margins, of course, have not meant a drop in dollar profits. Sales

have risen nearly four times over the 1929 total of $4 billion in chemicals and allied products. And post-tax profits, which were only $376 million in 1929, were over $1 billion last year. In the years ahead, continued chemical expansion will almost certainly be accompanied by still larger total profits, even though pressure of competition may drive profit margins on sales still lower.

▶ **Why Competition?**—The rise in competition is not simply a matter of more companies in the field. In fact, the number of establishments in chemicals and allied products in the 1914 Census of Manufactures (10,698) was slightly larger than the number reported for 1950 (10,339).

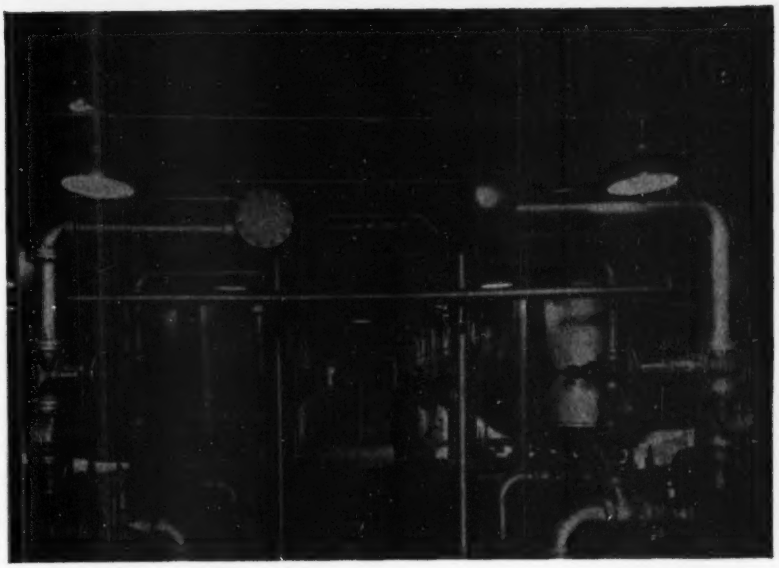
Competition has come rather from the entry of a dozen or more existing chemical companies into fields formerly occupied by one, two or three firms. Also, numerous companies in other industries have spilled over into chemicals.

Some of this outside competition is backed up with heavy financial resources. Oil companies entering petrochemicals are prime examples. According to the Windisch study, 58 oil companies now make one or more commercial chemicals. And they have a big advantage because they can utilize the proceeds of favorable tax treatment, such as the 27½% allowance against gross income for depletion, to finance the development of plastics or ammonia plants.

Competition in basic chemicals is coming also from other outside corporations with financial resources comparable to those of leading chemical companies. Examples are firms essentially in the following industries: glass, rubber, textile, iron and steel, machinery and photographic.

And some of these have been able to make a profitable operation of selling by-products or even waste products commercially. The refining of coke-oven by-products by steel companies is a classic example. Others are glass companies which can market excess soda ash and chlorine and rubber companies which can fit elastomers into their regular operations with relative ease.

▶ **No Profit Needed**—An important



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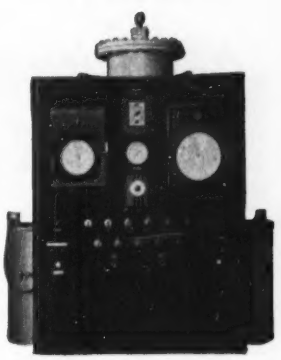

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ECONOMICS . . .

implication of outside competition is that it doesn't have to be very profitable to be worthwhile. A rubber company, for instance, can find good sense in selling a collateral chemical product without insisting on the same profit margin it makes on tires. And almost any price realized on a product that would otherwise be thrown away will make selling it attractive.

▶ **How to Stay Healthy**—What protection, then, has a chemical company against going broke in periods of price-cutting and below-cost competition? The advice Mr. Windisch gives investors in selecting chemical securities for stability of earnings might well be considered by those in the industry itself. He lists the following features as desirable for a company to possess:

- Unique products—produced by no more than three or four companies.
- Unique, low-cost processes—usually patented or secret.
- Preferred plant locations with raw material or marketing advantages.
- Consumer demand created by advertised trade names or quality prestige.

In such a dynamic industry as chemicals, however, the protected status of any one product is not likely to last long. This accentuates the need for active research programs to develop new products, new uses, new processes. It also points up the need for alertness in recognizing when an old product or process is no longer profitable.

▶ **Watch Yourself**—The trend toward diversification draws another warning from Mr. Windisch: "The dominant note in the expansion of several companies seems to be solely that of diversification and some of this has been lacking in foresight. Often products produced do not hang together or possess unity or coherence as far as raw materials are concerned." He expresses the opinion that some medium size chemical firms have been spreading themselves far too thin, trying to produce and sell too broad a line, in seeking the feeling of safety through diversification.

With the costly technical sales

service that's traditional in the chemical industry added to the expensive installations needed to move into a new line, diversification puts a heavy charge on the resources of any but the largest companies. "We can see some of the less diversified companies which are concentrated in growing lines riding through a storm better than those who have let their ambition outrun their treasury."

New Charts Trace Chemical End Uses

Can you name all the chemicals made from petroleum, from salt, from coal? Well until recently, we, too, would have been hard-pressed to compile such a list. But now it's been done for us—and for you—by the Stanford Research Institute.

In two large charts, SRI has traced the flow of chemical products, not only from petroleum, salt and coal, but from all other basic raw materials used by the chemical process industries. These charts have already been mailed to subscribers to the Institute's *Chemical Economics Handbook* and this month a special pamphlet is being prepared for non-subscribers.

Since their aim is to show in simple graphic form the immigration and consumption patterns within the chemical industry, the charts should be of particular value to executives, engineers and salesmen in companies that don't maintain large market research groups. The magnitude of information is truly tremendous. And it's all indexed and cross-referenced so that at a glance you get a complete picture even of those products that come from two or more materials.

In the organic field, all chemicals with a production magnitude of 25 million lb. or $5 million in 1953 are listed, plus some that are smaller now, but which are expected to hit this magnitude soon. Raw materials covered are petroleum, natural gas, coal, wood, sugars, fats and oils, cotton linters, starches, proteins, pentosaniferous materials (the carbohydrates used to make furfural), milk, coffee and seaweed.

(Continued)

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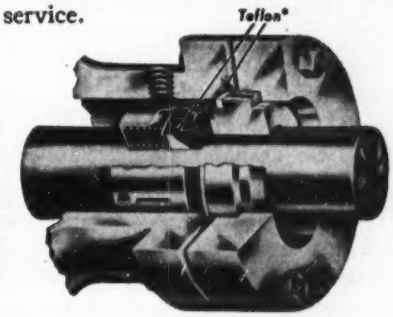

Your toughest problem can be the Type 9's next success story. **Use it on all rotating shaft applications, including: centrifugal, rotary pumps, mixers, agitators, autoclaves, other equipment.**

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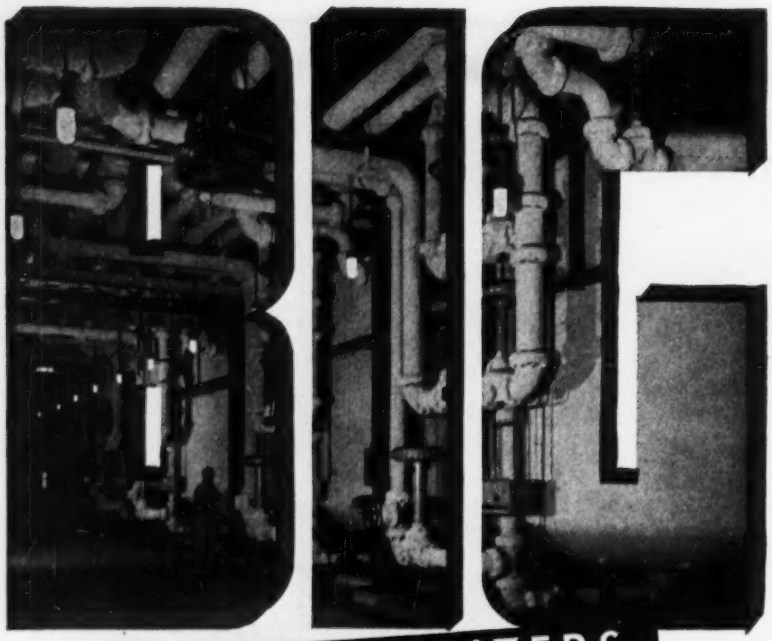

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ECONOMICS . . .

Criterion for the inorganic chart is a production volume of 50 million lb. or $5 million in 1953. Again, some chemicals that are not yet in that class, but which are developing rapidly, are included. Raw materials traced are sulfur, natural gas, coke-oven gases, pyrites, smelter and oil refinery gases, salt, brines, sea water, phosphate rock, sand, air, limestone, bauxite, cryolite, water, coke, potash and a host of minerals.

World Output of Man-Made Fibers Jumps 16%

Total world production of man-made fibers set a new record last year, according to *Textile Organon*. It rose to 4.53 billion pounds, up 16% over the 1952 production of 3.89 billion pounds. The man-made products also increased their share of the total fiber market from 17% in 1952 to 19% in 1953, as shown below.

World Production of Six Textile Fibers, Millions of Pounds

	1946	1950	1952	1953
Man-made fibers				
Rayon, acetate				
Yarn	1,112	1,927	1,840	2,084
Staple	579	1,565	1,732	2,058
All others	N.A.	170	321	385
Total	N.A.	3,662	3,893	4,527
Cotton	9,675	12,840	16,265	16,918
Wool	2,142	2,323	2,509	2,550
Silk	39	44	59	61
Six-fiber total	13,847	18,869	22,726	24,056

Although we're slipping slightly on a percentage basis, the U. S. remains far and away the world's largest manufacturer of rayon and acetate. Output in 1953 of 1.2 billion pounds gave us 29% of the total. Japan, with slightly more than half a billion pounds, was in second place—13% of the total. World rayon and acetate capacity in March of this year was 5.45 billion pounds, 31% of it in the United States. By December 1955, world capacity is expected to be over 5.8 billion pounds, 29.5% of it in this country.

Capacity for non-cellulosic textile fibers is rising, too—from 616 billion pounds in March of this year to an estimated 865 billion pounds by the end of 1955. Much of the recent

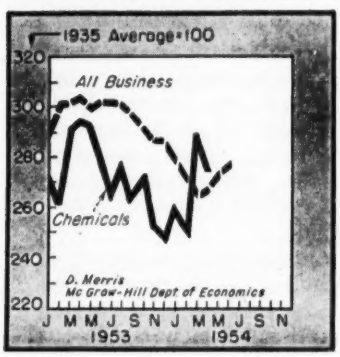
growth has been in foreign countries, as shown below. But the U.S. still accounts for 78% of the world's capacity—and production—as compared with 82% in 1952. By the end of next year, however, projected foreign growth is expected to reduce our share to about 71%.

World Production and Capacity of Noncellulosic Man-Made Fibers, Millions of Pounds

Country	Production 1950	1952	1953	Capacity* 1954	1955
Argentina	0.3	0.4	0.2	0.8	0.8
Belgium	1.0	1.5	2.5	4.0	4.8
Brasil	0	0	0	1.0	1.0
Canada	5.0	8.1	9.1	12.0	26.0
France	5.5	7.3	12.4	16.1	35.3
West Germany	2.0	8.8	13.2	18.0	22.0
Israel	0	0	0	0.3	0.7
Italy	1.3	4.7	8.0	10.0	15.0
Japan	1.0	8.2	15.0	30.0	60.0
Netherlands	1.1	2.0	2.4	4.0	6.5
Spain	0	0	—	0.3	4.0
Sweden	0	—	—	—	0.1
Switzerland	0	1.0	2.0	2.0	2.0
United Kingdom	9.0	16.0	20.0	48.0	75.0
United States	143.9	262.9	300.5	469.0	612.0
Total	170.1	320.9	385.3	615.9	865.2

*As of March 1954, Dec. 1955

CONSUMPTION INDEX . . .



Business Activity*(June)....278.4

Chemical Consumption

	May (Prelim.)	April (Rev.)
Index	**276.86**	**276.64**
Fertilizer	66.00	71.50
Pulp & Paper	31.89	30.85
Petroleum ref.	28.16	26.57
Iron & steel	13.71	12.79
Rayon	25.92	24.51
Glass	25.87	23.83
Paint & varnish	29.58	29.97
Textiles	9.71	9.84
Coal products	9.88	9.76
Leather	3.53	3.74
Explosives	8.00	8.10
Rubber	5.84	5.95
Plastics	18.77	19.23

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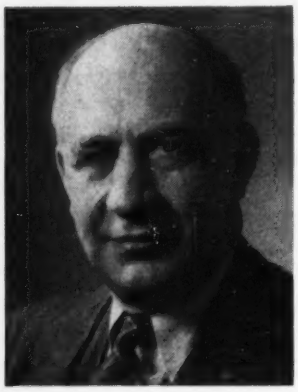
THIS MONTH'S

Names in



Clifford C. Furnas

MAN OF THE MONTH

Top-notch chemical engineer takes over as chancellor of the University of Buffalo.

". . . a tremendous honor and an enormous responsibility." With these words one of the country's most versatile chemical engineers, Clifford C. Furnas, took on a new job—chancellor of the University of Buffalo.

Dr. Furnas, long recognized as an authority on heat transfer, fluid flow and combustion, is bringing a varied and impressive career to his new post.

A former olympic athlete,* track coach, high school math teacher, university professor, research scientist, editor, engineering and research consultant and author of some half dozen books (including a Book of the Month Club selection) and numerous technical articles, Dr. Furnas was the director of the Cornell Aeronautical Laboratory at the time of his appointment.

► **Research Background**—How come a chemical engineer as head of an aeronautical laboratory? Well, Dr.

* Not only did he represent the U. S. in the 1920 Olympics at Antwerp, but he also held three Big Ten championships while at Purdue University. At graduation, he was awarded a medal for having the best combined scholastic and athletic record in the Big Ten Conference.

the News

P. C. Shaw

Furnas was chosen for the post on the basis of his reputation for being a top-flight researcher and research administrator.

Even while pursuing his doctorate at the University of Michigan he did some research work for the Illinois Steel Co. Later research work at the Bureau of Mines; again at Yale University, where he also taught chemical engineering, and with the National Defense Research Committee, where he coordinated a large research and development program, gave Dr. Furnas just the background that the Curtiss-Wright Co. was looking for in a research director. And in 1943 he was given charge of the C-W laboratory at Buffalo.

In 1946, when the laboratory was turned over to Cornell University, he stayed on—becoming director of the new Cornell Aeronautical Laboratory.

▶ **Universal Interests** — The new chancellor is a man whose interests are literally universal. Last year, he delivered a lecture before the ACS on nuclear engineering. This year he will talk on the sources of energy—another field in which he is regarded as an authority.

He has dealt with this in several books and articles. He has also concerned himself with the depletion of raw materials and the effect it will have on us—or more correctly, on our descendants.

Dr. Furnas is disturbed by the prevailing attitude that present-day energy sources and sources of raw material will last forever. Today's energy sources, including nuclear energy, he views as merely stop-gap measures. Ultimately, he feels, we must look to the sun as our prime source of energy.

When it comes to raw materials, Dr. Furnas is similarly concerned. As he points out, if the desire of the entire world for as high a standard of living as we in the United States enjoy were realized overnight, the rate of use of the earth's materials would jump 750%. And

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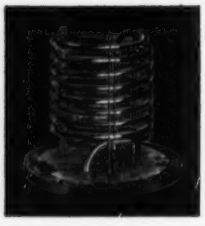

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NAMES . . .

this is exactly what's happening —albeit over decades, not overnight.

▶ **Vision, not Pessimism**—But he is no pessimist.* And that fact is the key to his accepting the chancellorship at Buffalo. A man of vision, he recognizes that providing for the future is all-important, and a prominent part of that providing is the supplying of trained men and women to meet the problems of the future. This is the responsibility of education.

From his new post Dr. Furnas will be able to take an active part in the job assigned to education.

This is more or less characteristic of him. He's a very active man to begin with, with many and varied interests.

▶ **Rugged Relaxation**—Now only a casual sports fan, he really gets little recreation. When he can take the time, his favorite sport—Mrs. Furnas's, too—is mountain climbing. A few years back, they scaled Mt. Whitney, and they've also conquered other peaks in both the Sierras and the Tetons, including the Grand Teton. This last he calls "a respectable climb."

Other pastimes which he and his wife enjoy together are listening to classical music and reading. In addition, they've written a book together, "Man Bread and Destiny." Of which he says that he acted as journalist while his wife, with a master's degree and great deal of experience in nutrition, was the expert.

Their only child, a daughter, was recently married. She is now studying for her Ph. D in zoology at Columbia. Her husband is studying medicine at Cornell. — HTS.

* Although, he refers to himself as "a short-time pessimist, a long-time optimist."

F. M. Simpson—Vice president and general manager of Petroleum Chemicals, Inc., with headquarters in New York.

Bradford E. Bailey—Chief chemical engineer with Brown, Blauvelt & Leonard, New York, formerly with Esso Laboratories.

Charles D. Luke

Newly appointed director of the Atomic Energy Commission Classification office, Dr. Luke has been professor and chairman of the Chemical Engineering Department at Syracuse since 1940, and was associated previously with the Standard Oil Co. of Louisiana. During the war he was operations officer for the gaseous diffusion plant at Oak Ridge, Tenn., and later served as consultant to the AEC. In his new appointment, he succeeds Dr. James G. Beckerley, who resigned to return to private industry.

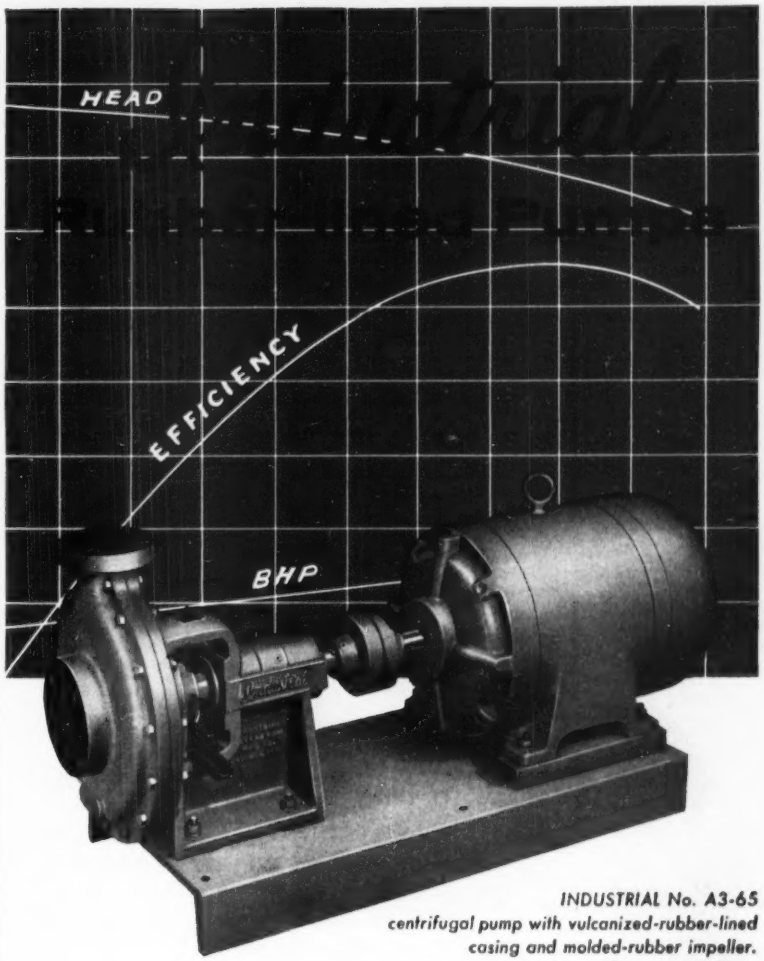
George W. Ewald—Executive vice president and technical director of Emjay Maintenance Engineers, handling production and development of new materials and processes in the corrosion control field.

William T. Cravens—Vice president and director of Cities Service Oil Co., Del., and manager of the refining division, succeeding Mr. Haugen.

Lee N. Haugen—Vice president and general manager of Cit-Con Oil Corp. at Lake Charles, La.

Rex R. Lloyd—Joined Titanium Metals Co. of America at Henderson, Nev. after four years as head of Boulder City station of the Bureau of Mines.

Warren H. Brand—Director of engineering and research of Conoflow Corp., Phila.; prior to this



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These pumps are made in a range of sizes with capacities up to 240 gpm., operating heads up to 240 feet, and ¾ to 15 hp. They are furnished either with or without base, motor, and coupling

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NAMES . . .

post, he was supervising engineer of the Industrial Instruments Engineering Section at Oak Ridge.

I. A. Solomons—Manager of the Brooklyn Laboratories of Pfizer's Chemical Research and Development Division. **Franklin S. Chance, Jr.** has been promoted to assistant director in charge of development in the same division.

Clifford F. Rassweiler

Mr. Rassweiler has been elected honorary chairman of the American Section, Society of the Chemical Industry, for 1954-55. Vice chairman of the board of directors and vice president for research and development of Johns-Manville, N. Y., he has been active in the field of research and development for almost thirty years.

H. E. Martin—President and director of Metal & Thermit Corp., following a 25-year association with Babcock & Wilcox.

David S. Weddell—European representative for Monsanto Chemical Co., succeeding **Edward B. Seaton**, who is returning to the U. S. to join the company's overseas division.

Donald B. Benedict—Works manager of Carbide and Carbon Chemicals Co. at Texas City, Texas.

Henry B. Smith—Technical director for engineering and commer-

cial development in General Foods' Central Laboratories. **Robert C. Reeves** was promoted from laboratory director to technical director of product and process development in this company.

C. I. Bradford—President of Rem-Cru Titanium, Inc. and member of the board, formerly vice president and director of operations.

Leon H. Nelson—Director of conservation and yield control for the Crucible Steel Co. of America, with headquarters in Pittsburgh.

Rollin P. Smith—Assistant to **Alex Stewart**, director of research for National Lead, N. Y.

Robert D. Lowry—Technical director of the Cryovac Division of Dewey and Almy Chemical Co. in Lockport, N. Y.

James S. Whyte—Vice president in charge of engineering of Shawinigan Chemicals, Ltd., Falls plant.

Fred G. McLaughlin—Director of research, Sure-Seal Corp., Salt Lake City, formerly chief research and control chemist for Quaker State Oil Co., McKean, Penna.

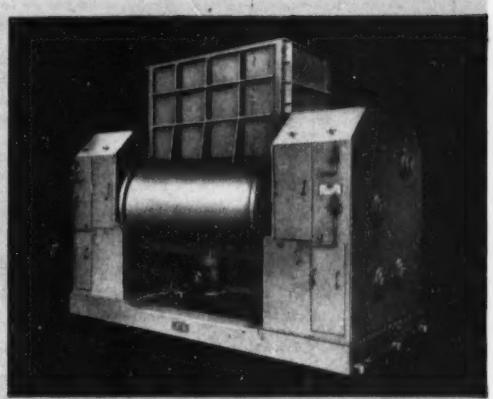
Richard M. Lawrence—Director of business research for Wyandotte Chemicals Corp., formerly senior market analyst in the general development dept. of Monsanto.

Simon Askin—Elected president of Armed Forces Chemical Association, N. Y., succeeding Major General **W. N. Porter**, retired.

Lawrence M. Richards and **Edward B. Doll**—Assistant directors of research, physical sciences division, Stanford Research Institute.

William H. Evans—Vice president of Diamond Alkali Co., which has also promoted **John W.**

IN THE Paper Industry



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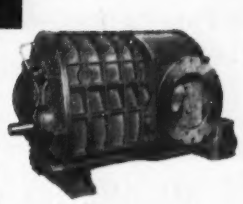

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by the

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Plastic materials challenge industry with new concepts of design, engineering, construction, processibility and usefulness.

The properties of plastic materials, when correctly used, open up great new areas of service to industry and the public.

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I. Understand thoroughly the properties and limitations of all plastic materials handled by us;

II. Apply the correct plastic materials to all industrial end uses, designing and engineering them for maximum value, performance and safety;

III. Use great care to select the correct plastic materials for all consumer items, designing and engineering them to insure value, satisfaction, safety and pleasure to all users;

IV. Sell plastic materials, and all industrial and consumer items made therefrom, on the merits of the materials, applications and design, and free of extravagant, insupportable claims.

All to the end that plastic materials already available, and others that may come, will bring to industry and public alike all the benefits, economies and satisfactions inherent in these versatile engineering and construction materials.

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Raymond B. Seymour, President

We firmly believe that the practice of these principles which are completely in accord with the ATLAS POLICY will minimize misapplication of Plastic Materials of Construction. Customers should have confidence in firms complying with these principles.

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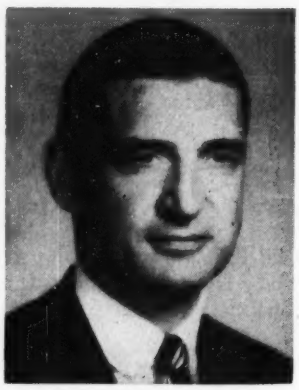
NAMES . . .

Mantz to the position of general manager of the Silicate, Detergent and Calcium Division, **L. T. Welshans** to general manager of the Cement and Coke Division, and **C. R. Brown** to assistant works manager at Painesville.



William E. McGuirk, Jr.

Former vice president of W. R. Grace & Co., Mr. McGuirk has been appointed executive vice president of the Davison Chemical Co. Division of Grace. A graduate of the U. S. Naval Academy, he has been associated with Kuhn, Loeb & Co. and with the U. S. Atomic Energy Commission.

Stephen F. Learnard–Joined the staff of Arthur D. Little Inc. of Cambridge, following his graduation in chemical engineering from M.I.T.

T. H. Paulsen–Chief process engineer of Sinclair Chemicals, Inc.

H. A. Leedy–Re-elected president of the Midwestern Air Pollution Prevention Association; director of Armour Research Foundation of Illinois Institute of Technology.

A. T. Beauregard–Executive assistant to the general manager of the Inorganic Chemicals Division of Monsanto.

C. K. Lockwood–President of the Alloy Casting Institute; also vice president and director of Shawinigan Chemicals Ltd.

John J. McKetta, Jr.—Professor of chemical engineering at University of Texas; formerly editorial director of the *Petroleum Refiner*.

N. B. Sommer—President of Commercial Chemical Development Association, succeeding W. E. Kuhn of the Texas Co. Dr. Sommer is manager of American Cyanamid's New Product Development Dept.

E. Ralph Rowzee

A prominent Canadian administrator and chemical engineer, Mr. Rowzee has been elected president of the Chemical Institute of Canada for 1954-55. He is vice president and manager of Polymer Corp. Ltd., Sarnia, Ontario, which plant he designed, built and organized. He was active in initiating Canada's synthetic rubber program in 1942.

John Kasch—Technical assistant to the vice president and manager of manufacturing of Pan American Refining Corp., N. Y.

H. W. Barlow—Director of the Institute of Technology at Washington State College, succeeding **William A. Pearl**, who resigned to become Bonneville power administrator last January.

Herbert W. Rogers—President of Lithium Corp. of America Inc., former secretary of the company.

Alfred B. Babcock Jr.—Chief project engineer of the Borden Co.'s

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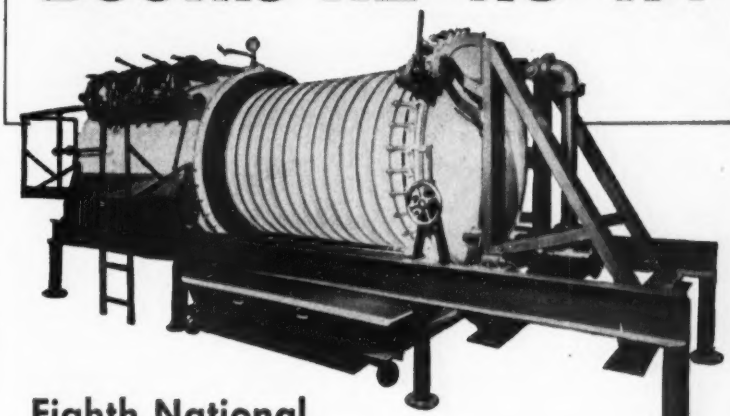
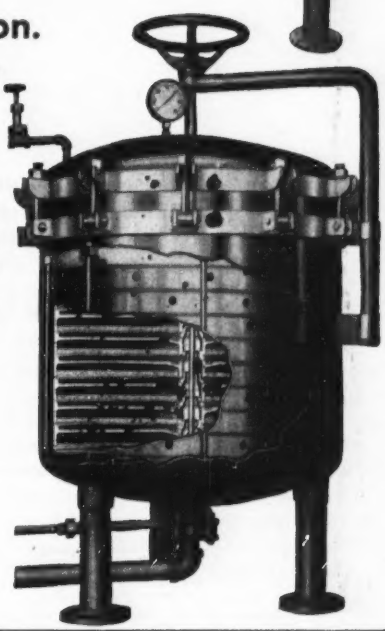


Eighth National Chemical Exposition. Chicago—October 12 to 15, 1954.



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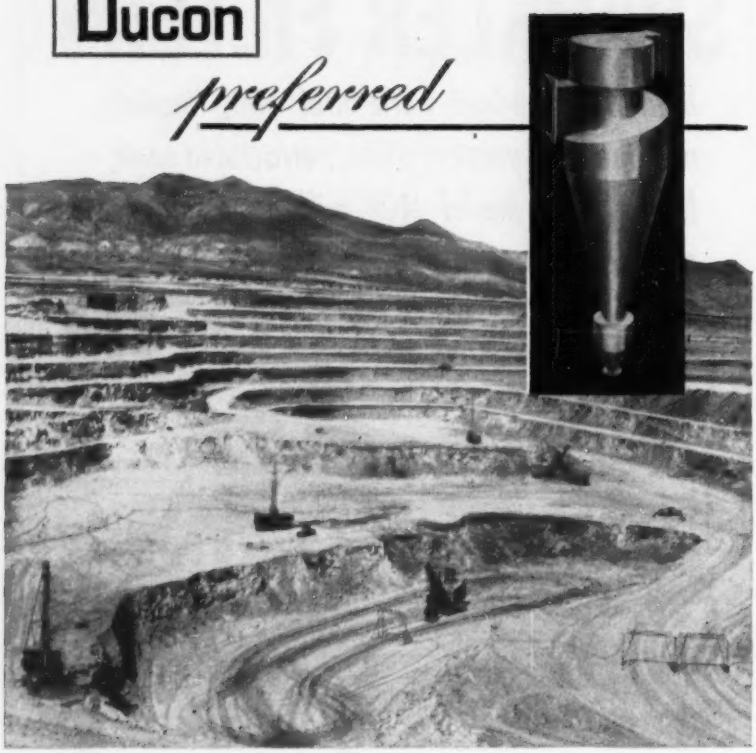

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NAMES . . .

Chemical Division, N. Y.; formerly associated with the AEC New York operations office.

Augustus B. Kinzel–Director of research, Union Carbide and Carbon, in charge of coordinating research activities of all divisions of the company.

Gerald Fisher–Pollution control coordinator for the General Petroleum Corp., which he has served for over 30 years.

Ray T. Hanson–Western manager of the Borden Co.'s chemical division with headquarters at Seattle, succeeding **William R. Moffitt**, promoted to vice president and technical director of the firm in N. Y.

Palmer H. Whitlock–New York operations manager of Seatrain, Lines Inc., formerly manager of Houston branch operations.

J. E. Plume–Research and development engineer in the Light Hydrocarbon Department of Dow Chemical at Freeport, Texas.

Obituaries

Charles F. Roth

President of the International Exposition Co. and manager of the Exposition of Chemical Industries, Charles Roth died June 24 as the result of an automobile accident. In 1915, while chief chemist for Standard Oil of New York, he organized the first chemical exposition, to alleviate strategic material shortages of World War I. In a forty-year career, he organized and

managed more than sixty industrial expositions.

Sterling Temple, former director of the Chemical Research Division of the Electrochemicals Dept. of Du Pont, and 1938 winner of the Jacob F. Schoellkopf Medal, died at his home in Niagara Falls on May 1.

Karl Taylor Compton, chairman of the Corporation of MIT and a director of McGraw-Hill Publishing Co. for the past five years, died June 22 in New York Hospital. He was one of the country's foremost physicists and a policy planner in atomic bomb development.

W. O. Hinkley, director of the testing laboratory of the Raymond Division of Combustion Engineering Inc., died unexpectedly at his home on June 8.

Moody Lewis Crowder, treasurer of the Society of Cosmetic Chemists and assistant manager of Research and Control Labs of Pond's Extract Co., Clinton, Conn., died on June 13.

H. Lester Glover, who retired in 1941 as superintendent of the Falls plant of Merck & Co., died in June in Philadelphia. He was the grandson of John Glover, inventor of the Glover tower used in sulfuric acid manufacture.

Lloyd Williamson, 64, president of the Mascot Oil Co. and Lakeport Petroleum Co., died July 3 in Huntington Lake, Calif.

Saul Dushman, who retired as assistant director of the General Electric Research Laboratory in 1948, passed away July 7 in Scotia following a long illness. He devised the "Dushman equation," used in physical-chemical problems.

Charles S. Davis, 77, chairman of the board and former president of Borg-Warner Corp., died in Paris on July 2 while touring Europe.

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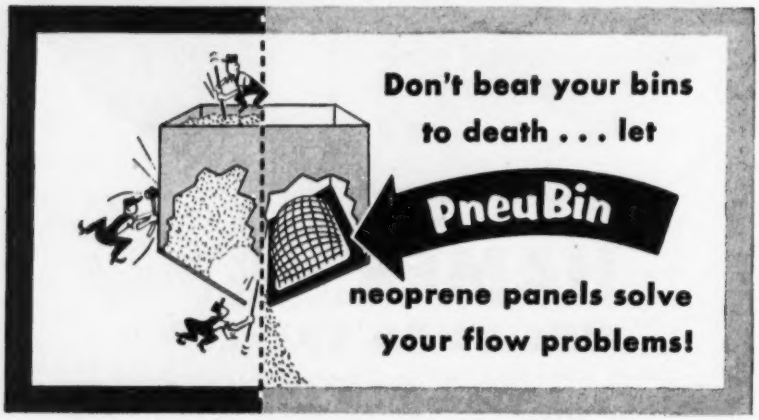

Sizes: PneuBin panels are available in 14 standard sizes, 4" to 24" wide, 6" to 72" long. Special sizes can be made if required in quantity.

Send for "Flow Stoppage Report" and free literature. PneuBin engineers will gladly make recommendations, with no obligations on your part.

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THIS MONTH'S

Technical

API Project 6

HYDROCARBONS FROM PETROLEUM. By F. D. Rossini, B. J. Mair, and A. J. Streiff. Reinhold Publishing Corp., New York. 556 pages. $18.50.

Reviewed by K. A. Kobe

The results of over 300 man-years of work on American Petroleum Institute Project 6 are reported in this American Chemical Society Monograph 121. Begun in January 1927, A.P.I. 6 is now the oldest active project in the A.P.I. research program. It operated first at the National Bureau of Standards under E. W. Washburn until 1934 and under F. D. Rossini since that time. In 1950 the project moved with Dr. Rossini to the Carnegie Institute of Technology, where it now operates. The present staff consists of ten full-time members and a number of part-time workers.

The original project title of "The Separation, Identification and Determination of the Chemical Constituents of Commercial Petroleum Fractions" was later changed to "Analysis, Purification, and Properties of Petroleum Hydrocarbons" which is more descriptive of the work being done.

The book is divided roughly into three sections dealing with the three divisions in the present title: analysis, purification and properties. The first section describes purification procedures used on the project. These are regular distillation, azeotropic distillation (but not extractive distillation), distillation at different pressures and at very low pressures, extraction, adsorption, crystallization, and extractive crystallization with urea (but not thiourea). Thermal diffusion methods have not been used on the project and are not discussed.

The physical properties used for the characterization of the hydrocarbons are the boiling points and vapor pressures, densities, refractive indexes, freezing points and

Bookshelf

L. B. Pope

molecular weights. Vapor pressures are correlated by the Antoine equation, and a method is shown which simplifies the least squares procedure for fitting the equation to the data. The method used to evaluate the purity of the hydrocarbon from the freezing point is given. Analyses for carbon and hydrogen must be made and project methods and refinements are described. One of the objectives of the project is to prepare and distribute standard samples of hydrocarbons of high purity. The procedures for purification and testing of purity are given with a list of compounds now available.

The last third of the book describes the work done on the separation of pure compounds from petroleum itself, from the gasoline fraction, the kerosene fraction, the gas-oil fraction, and lubricant fraction of one petroleum. Then several petroleums are compared, and also several gasolines, alkylates and hydrocodimers.

In addition to the usual author and subject index, appendixes list the 141 papers published by API Project 6 and give author and subject indexes of these papers. References to work other than that of API 6 are given at the end of each chapter.

Undoubtedly the greatest contribution of this book is its complete description of the apparatus used, the technique employed and the interpretation of the results obtained. The descriptions are complete, drawings are detailed and scaled, fold-out charts give distillation curves of petroleum fractions, and frequent tabulations summarize the vast amount of data. References are always given to the original work, as APIRP6-141, in which the apparatus, technique and results may be presented more fully.

This volume is a fitting "Silver Anniversary" present to the public by the American Petroleum Institute and its Research Project 6—an outstanding summary of an outstanding research project.

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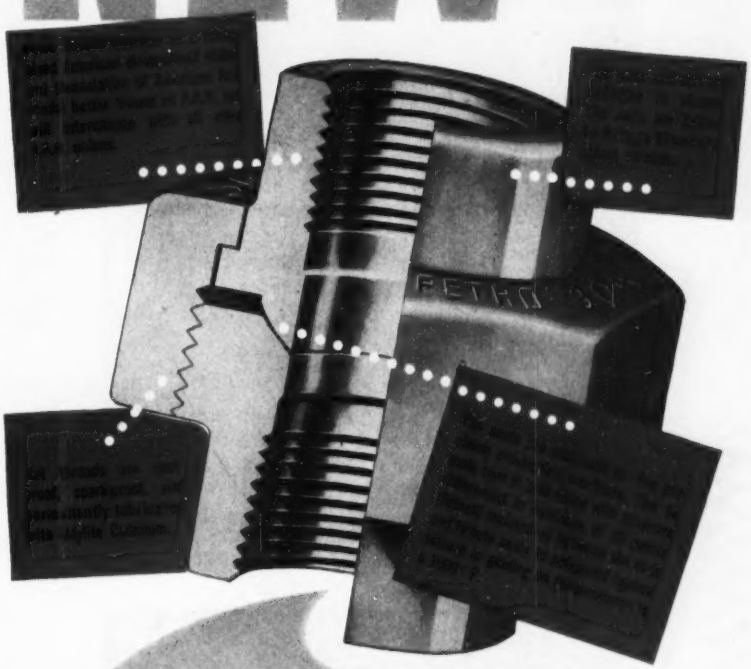

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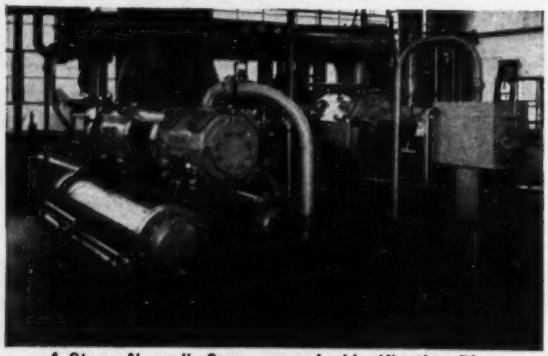

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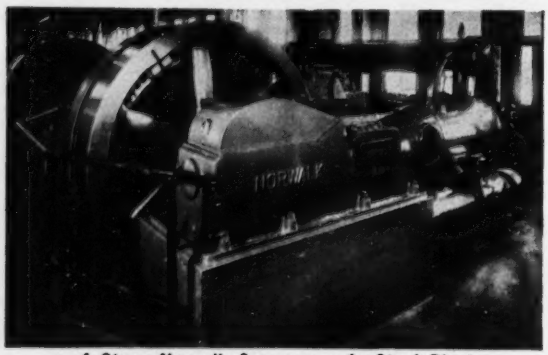
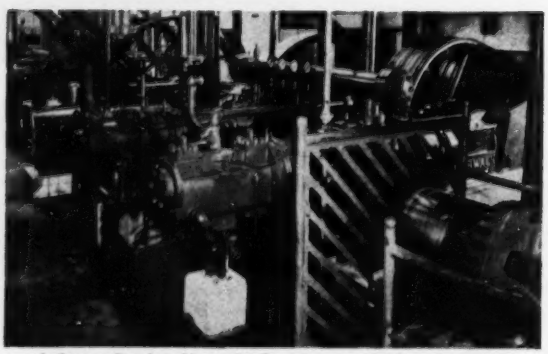


4 Stage Norwalk Compressor in Steel Plant



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Textbook

INORGANIC QUALITATIVE ANALYSIS. 3rd edition. By Harold A. Fales and Frederic Kenny. Appleton-Century-Crofts, Inc., New York. 284 pages. $3.

Reviewed by J. Steigman

The revised edition of this text adds to the previous edition both theoretical and experimental material, including condensed discussions of modern acidity, radioactivity as an analytical tool, colloidal behavior of some precipitates, and chromatography. In addition, there is an extended section on systematic semi-micro anion analysis for carbonate, borate, sulfide, sulfite, sulfate, phosphate, thiocyanate, iodide, bromide, chloride, nitrate and nitrite.

This text, like its predecessors, is primarily designed for a one-semester course (although there now appears to be sufficient experimental material in it for a more extended study). The theoretical portion of the book covers chemical arithmetic, types of compounds, electrolytes, ionization, hydrolysis, solubility product, complex ions and redox theory. This section is quite condensed, but rather complete for a one-semester course. The writing is clear, and the style is reminiscent of the well-known text on quantitative analysis by the same authors.

The experimental part of the text handles the traditional sulfide separative scheme of the twenty-odd usual cations on a semi-micro basis. It is possible to make concentration estimations of unknowns, if it is so desired. There are, in addition, supplementary experiments in connection with each cation sub-group, and in connection with various physico-chemical principles (e.g., the effect of acidity on metallic sulfide precipitation).

One might wish for a more extended treatment of the descriptive inorganic chemistry of the cations than is afforded by this book, as well as some introduction to specific and special organic reagents in separative and confirmatory tests. However, since the stated purpose of the book is to "present clearly

some important fundamental principles of chemistry and to use as a framework for the study of these principles thoroughly tested qualitative procedures," the only comment that can be made is that if the purpose is accepted, it has been well executed.

Dispersion

FLOW PROPERTIES OF DISPERSE SYSTEMS. Edited by J. J. Hermans. Interscience Publishers, Inc., New York. 445 pages. $9.90.

Reviewed by G. E. Alves

As one of the series on Monographs on Deformation and Flow, this book brings together in one volume a good coverage of the background information on a wide variety of disperse systems.

The monograph is well written and very easy to read. It is documented with over 15 pages of literature references which should be of value to those chemical engineers interested in additional information.

The text is divided into ten chapters with each chapter covering a different disperse system. Three chapters are devoted to solid-liquid suspensions and dilute solutions of flexible chain molecules presenting discussions of viscosity, non-Newtonian flow properties, and the onset of turbulence. The preparation, stability and viscosity of emulsions are discussed. Gel formation, structure, and properties are treated in some detail. Such topics as break-up of a liquid jet, measurement of drop size, break-up of large drops, and evaporation of drops are given in a chapter on liquid sprays. Atomization of liquids and related topics are also covered. A review of the literature on the structure, stability and properties of foams is presented. Smoke, including such subjects as formation, sedimentation, diffusion, and coagulation, is covered in one of the last chapters. The same chapter includes the flow properties of smoke such as flow through a channel and through a fibrous bed, and the movement of smoke in electric, thermal, and ul-

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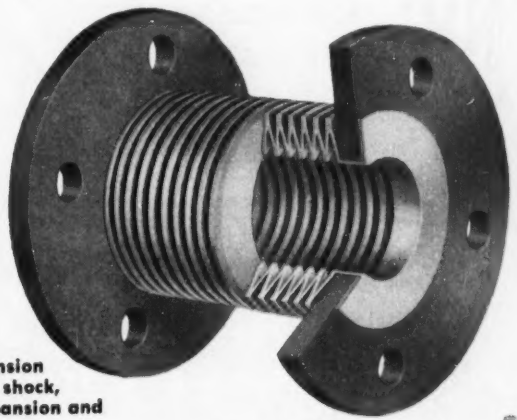

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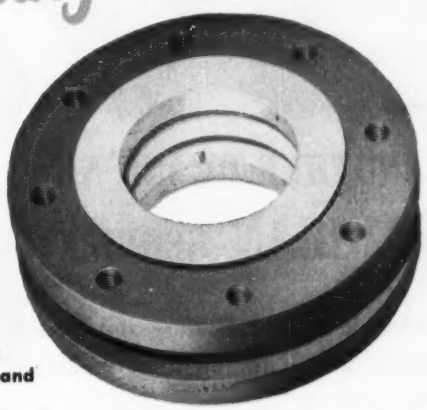

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trasonic fields. The last chapter is devoted to powders, solid materials of particle diameters between 0.1 and 100 microns. The properties of the settled bed, heap, flowing powder, free flow through tubes and holes, and fluidized powders are discussed.

The book can be highly recommended to chemical engineers interested in a good background or a reference on the subjects covered.

Long and Short

INTRODUCTION TO CHEMISTRY. By R. T. Sanderson. John Wiley & Sons, Inc., New York. 542 pages. $5.50.

Reviewed by M. L. Branin

In the preface of his new Introduction to Chemistry, Prof. Sanderson of the State University of Iowa says, "This book is long on explanations and short on purely descriptive chemistry," adding, later on, "What I have tried to do in this book is to give only the most essential information, and to explain it as thoroughly and simply as possible." In your reviewer's opinion, the author has gone far towards achieving this difficult goal. The book is written in a refreshingly easy and straightforward style, making it both readable and understandable, and these factors should help to sustain interest.

Among the unusual features of the book are: a "Special Help" section at the end of each chapter which includes questions, summaries, and/or explanations; a chapter on the history of chemistry, at the back; and for the student who has not yet definitely decided on a career, a chapter entitled, "Earning a Living as a Chemist."

Concepts of atoms, molecules, atomic and molecular weights are introduced early (chapter 2), as are chemical names and formulas (chapter 5). The latter is followed, in chapter 6, by thumb-nail sketches of the properties of 18 important chemicals of commerce, from sodium chloride to ethyl alcohol.

Skillfully woven into the descriptions is a discussion of the gravimetric laws, with illustrative ex-

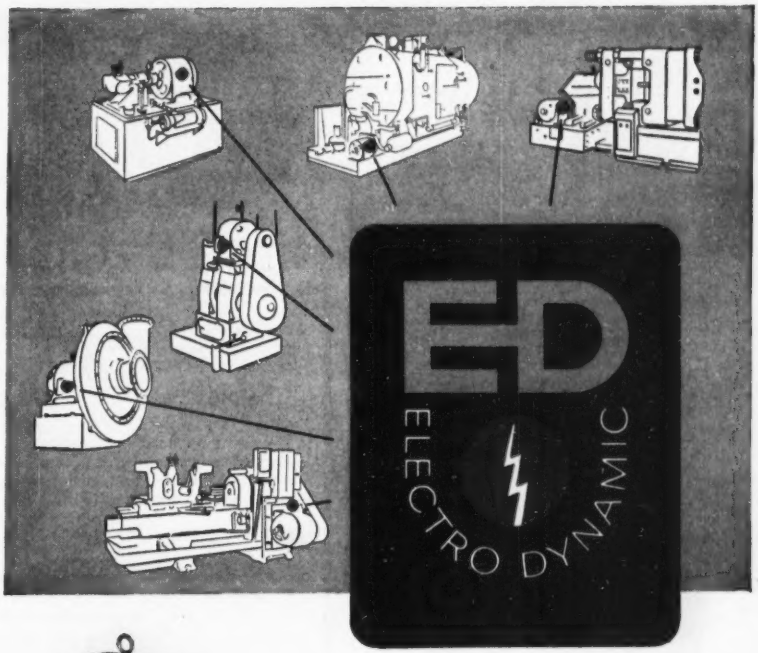
amples, so that what at first appears to be purely descriptive develops into an exposition of basic chemical laws and principles. Likewise skillfully treated are the concepts of atomic and molecular structure, valence, ions and ionization potentials, and chemical bonding in a single chapter titled, "Why Elements Combine, and How."

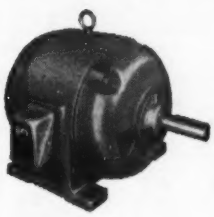
Among the topics covered early in the book are oxidation-reduction and the electrical properties of metals and non-metals. On the other hand, oxygen and hydrogen seem rather out of place midway of the book or beyond (chapters 17 and 20), these elements being perhaps more familiar to college freshmen than any others, and much of the information concerning them being necessarily repetitive.

Metals and the reduction of their ores are restricted to one chapter of 18 pages, with the discussion limited to the more common metals of commerce. The treatment of nuclear changes and nuclear energy is deferred to near the end of the book.

Prof. Sanderson's book is thoroughly modern in appearance and treatment, and, while it does not contain any photographic illustrations, it does have many well-executed line drawings to illustrate structure and principles. A few of them, however, are animated and for that reason may be objectionable to some individuals. The book also contains a total of 24 tables of uniformly good quality. There are questions at the end of many chapters, but few mathematical problems. Mathematical applications of chemical theory seem to have been kept at a minimum.

It would seem that this book is particularly well-suited to the non-chemical major, inasmuch as basic theory and principles are interestingly and lucidly treated and because undue stress is not placed on the mathematical aspects of the subject. Accompanied by a good problem manual it may be suitable for chemistry majors and engineers, although some will incline to the view that it is not sufficiently inclusive for this purpose.





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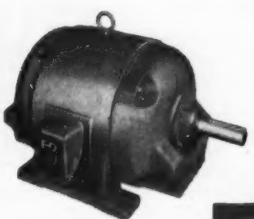

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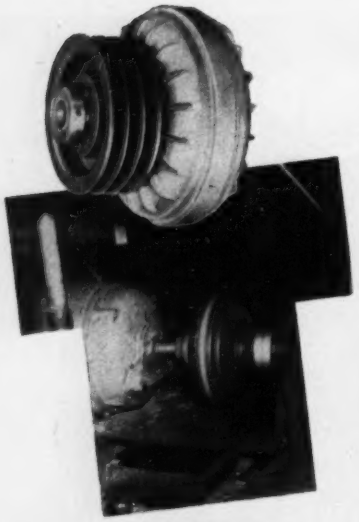

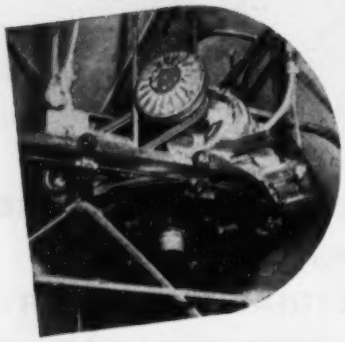

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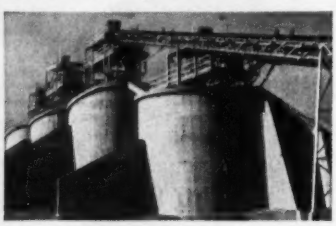
On Puget Sound at Steilacoom, Kaiser Engineers designed and recently completed one of the nation's most modern aggregates plants to supply the growing demand for sand and gravel in the Pacific Northwest. A unique feature of the plant's



construction was the erection of serpentine walls in the sand and gravel storage areas to eliminate dead space. The new plant's flexibility of operation is such that it not only can handle most common sizes of gravel, but also any other specific sizes ordered by customers. Its crushing and screening capacity is 375-500 tons per hour.

Conditioning of Water for Industrial Use is the title of a new book, written by Sheppard T. Powell being published by McGraw-Hill this month.

This modern guide to water conditioning describes the various types of apparatus in detail, including design features, control required for efficient performance, cost of installation and operation and other pertinent information.

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THIS MONTH'S

Recent Books

Air Pollution

Various sections of this manual on air pollution, have been published before—but this is the complete job. It has information on types of air pollution, legislative requirements, technical methods of handling; and suggestions for getting the cooperation of employees, public officials and the public. There's a 54 page bibliography. 180 pages.

"Air Pollution Abatement Manual." Manufacturing Chemists' Association, Inc., 1625 Eye St., N. W., Washington 6, D. C. $6.

Lead Handbook

Published to answer many questions about how lead can be used in the chemical process industries. Grade of lead, and properties are listed. And some additional features: dimensions of lead fittings; corrosion data. 48 pages.

"Lead Handbook For the Chemical Process Industries." Federated Metals Division, American Smelting and Refining Co., 120 Broadway, New York 5, N. Y. No charge.

Oil Facts

An illustrated reference booklet, dealing with the oil industry. There are short sections on how oil originated, how it is found, drilled, produced, transported, refined and used. Not a technical treatment—nevertheless it contains some valuable information. 32 pages.

"Facts About Oil." American Petroleum Institute, 50 W. 50th St., New York 20, N. Y. No charge for single copies.

Alloy Steels

This is a case-history treatment of where and how alloys steels can be used. Sixty case studies are in-

Pamphlets

cluded—each stating a problem and showing how replacement of carbon-steel parts with alloy steel, saved time and money. Not a technical treatise; it shows what general benefits can be derived without going into the specific grades of alloy that should be used. 208 pages.

"Alloy Steels Pay Off." Climax Molybdenum Co., 500 Fifth Ave., New York 36, N. Y. No charge.

Wet Strength

A monograph—directed to pulp and paper people—on a subject having wide interest recently: wet strength of paper and paperboard. There's a chapter on procedure for making wet-strength papers, including a short discussion of equipment and corrosion problems. Other chapters deal with the chemistry of wet strength (mechanism, curing) and test methods (tensile strength, analysis for urea and melamine). It ends up with a 3-page chapter on markets and uses.

"Wet Strength in Paper and Paperboard." TAPPI monograph No. 13. Technical Association of the Pulp and Paper Industry, 155 E. 44th St., New York, N. Y.

Tin

Here is a compilation of all published data on atomic, physical, physico-chemical and metallurgical properties of pure tin. Tin alloys are not covered in this booklet. 55 pages.

"The Properties of Tin." Tin Research Institute, Inc., 492 West Sixth Ave., Columbus 1, Ohio. No charge.

Chemical Equilibrium

Presents a brief outline of the theory of reaction equilibrium calculations and how they are applied. Equations are then developed for

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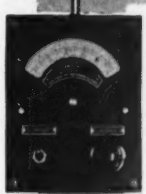

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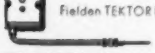

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solution of complex equilibrium problems. And various solution methods (Brinkley, Newton, Crout) are discussed. 124 pages.

"The Calculation of Chemical Equilibrium in a Complex System," by K. A. Kobe and T. W. Leland. The University of Texas, Bureau of Engineering Research, Austin, Tex. $2.

Pulp and Paper

The annual year book of the technical association of the pulp and paper industry. Officers of local TAPPI sections; authorized committee projects; list of TAPPI special reports; a TAPPI index; take up about a quarter of the book. The rest is an alphabetical directory of members. 366 pages.

"1954-1955 Year Book." Technical Association of the Pulp and Paper Industry, 155 E. 44th St., New York 17, N. Y. $2.

Bituminous Coal

If you want facts and figures on the coal industry—here they are. This is a well illustrated (graphs, charts, cartoons, pictures) booklet with statistics on consumption, coal reserves, production, transportation, markets and uses, employment, and safety. 168 pages.

"1953 Bituminous Coal Annual." Bituminous Coal Institute, Southern Building, Washington 5, D. C. No charge.

ASTM Standards

Here are seven 1953 supplements to the book of ASTM standards. They contain new and revised specifications. Part 1—ferrous metals. Part 2—non-ferrous metals. Part 3—cement, concrete, ceramics, thermal insulation, road materials, waterproofing, soils. Part 4—paint, naval stores, wood, fire tests, sandwich constructions, building constructions, wax polishes. Part 5—fuels, petroleum, aromatic hydrocarbons, engine antifreezes. Part 6—rubber, plastics, electrical insula-

tion. Part 7—textiles, soap, water, paper, adhesives, shipping containers. Each part is complete with a cover and table of contents.

"1953 Supplement to Book of ASTM Standards, Including Tentatives." American Society For Testing Materials, 1916 Race St., Philadelphia 3, Pa. $3.50 for each part.

British Fertilizer Review

Since the last war, there's been a great increase in fertilizer consumption in England. This booklet tells of the many steps taken—expansion of granulated fertilizers, setting up of triple phosphate plants, development of ammoniated superphosphate and nitrophosphate, introduction of mechanical handling equipment— to meet this rising demand. 29 pages.

"A Review of Productivity in The Fertilizer Industry." British Productivity Council, 21 Tothill St., London, S.W. 1. 2s.

How To Get P.E. License

A step-by-step guide outlining the procedure for getting your professional engineers license. Included are instructions on how to file applications for greatest effect; how to prepare for the written exam; what the qualifications are in N. Y. state. 35 pages.

"Guidance Procedure For the New York Professional Engineers License." By John D. Constance, 625 Hudson Terrace, Cliffside Park, N. J. $1.

Pump Specification

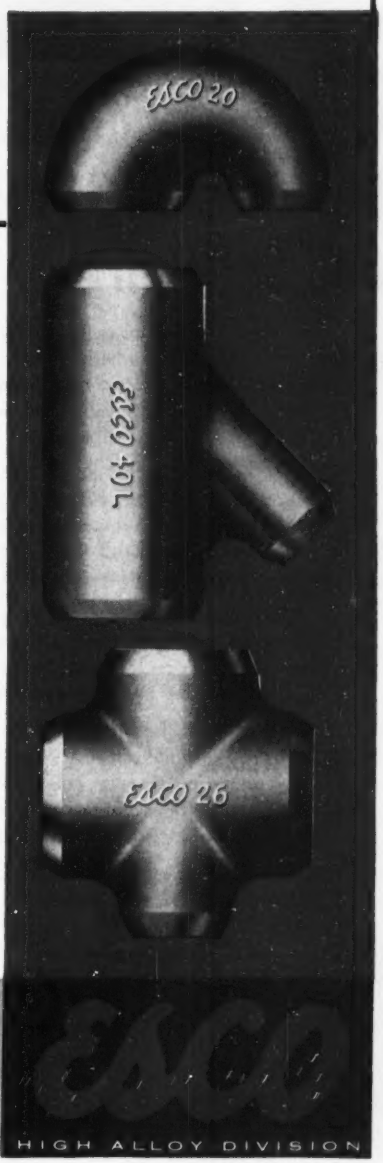
A tentative specification for centrifugal pumps used in general refinery services. Designed to aid the purchaser of such pumps, it covers design, materials, inspection and test directions. 15 pages.

"Tentative Specification For Centrifugal Pumps." American Petroleum Institute, 50 W. 50th St., New York 20, N. Y. No charge.

ESCO

WELDING FITTINGS CAST IN ALL CORROSION and HEAT RESISTANT ALLOYS

give you freedom of design on piping systems



You no longer need to let alloy problems or unusual shapes or sizes of fittings limit the design of your piping systems. *ESCO* can supply you with fittings of all standard corrosion and heat-resistant alloys, including 0.03 max. carbon, or specially modified alloys in wall sections and dimensions to meet your most exacting requirements.

You get fast delivery, even on small quantities. No waiting for long runs of standard production items to be completed before your job can be started. Big orders can be handled efficiently and economically, too. *ESCO* pays the freight on orders of $300 or more.

ESCO also offers you centrifugally-cast Spuncast® pipe, all types of flanges, screwed fittings and flanged fittings cast specifically to meet your needs and analyses. Complete engineering assistance for your piping system is available, if needed. Ask for details or write for free booklets "*ESCO* Stainless and High Alloy Products for the Process Industry" ..."How to Cut Costs With *ESCO* Spuncast"..."*ESCO* Cast High Alloy Fittings".

...the toughest corrosion problems wind up at...

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ELECTRIC STEEL FOUNDRY CO.

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ESCO International and New York Office
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Other Offices and Warehouses
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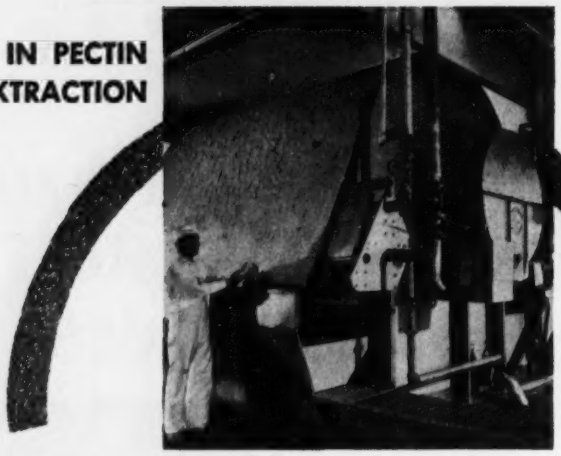
IN PECTIN EXTRACTION



One FEinc Continuous Filter Replaces Two Presses and Six Men

Looking at this clean, quiet picture, you'd never know this filtration job was formerly a hot, steamy mess, requiring six men per shift to load and unload wet, acid-laden press blankets, racks and press cars of two stop-and-go hydraulic presses.

Now it's a smooth-running, *really continuous* filtration operation, on this big FEinc String Discharge Filter. Only one operator is now required, with very little to do except watch the cake roll off hour after hour. Even the daily washup takes little time and effort.

Pectin recovery is reported to be as good as formerly. Losses due to leakage and spillage have been eliminated. The dynel cloth on this filter lasts more than a year . . . a substantial saving in the cost of filter cloth.

The pulp is lifted from the filter by continuous orlon strings . . . the famous FEinc String Discharge which successfully handles all types of cakes ranging from thin slimes to thick heavy sludges. There's no smearing, blinding or plugging of the fabric, and no loss due to "blow-back."

You too can improve production rates at lower cost in many of your filtration operations with the continuous . . . *really* continuous . . . FEinc String Discharge Filter. Find out more about what these versatile efficient filters can do for you. And ask about the new FEinc Horizontal Rotary Vacuum Filter for crystalline or fibrous pulps. Write today.

Ask for Bulletin 103

Filtration Engineers, Inc.

CUSTOM DESIGNERS AND MANUFACTURERS OF ALL TYPES OF CONTINUOUS FILTRATION EQUIPMENT

FEinc

40 155 ORATON STREET • NEWARK 4, N. J.

THIS MONTH'S

Firms in

New Names

The Bersworth Chemical Co., Framingham, Mass., has changed its corporate name to "Versenes Inc."

New Locations

Maurice Holland, industrial research adviser, has relocated his offices in the Lincoln Bldg., 60 East 42nd St., New York.

Arthur J. Norton, R. F. D. #1, Vashon, Wash., has moved his consulting offices from the prior location in Seattle.

Nat'l. Ass'n. of Manufacturers has located its headquarters at new facilities at 2 East 48th St., New York.

Chemstrand Corp. has relocated its general sales headquarters in the Empire State Bldg., New York.

New Representatives

DeLaval Steam Turbine Co., Trenton, N. J., has appointed the Haytian Practor & Equipment Co., Haiti, as its representative.

Charles Englehard Inc., East Newark, N. J., has appointed Carl H. Schmidt Co. as sales representatives for its gas analysis equipment.

The Garman Co., Inc., St. Louis, has chosen the Water-Saver Corp., New York as representative for its water conditioning products.

Black, Sivalls & Bryson, Inc., Tulsa, has named the Industrial Process Equipment Co., St. Louis, as representative.

Allied Chemical & Dye Corp., nitrogen division, has become the sole distributor in the U. S. for ammonium nitrate-limestone fertilizer produced in Belgium.

Ampco Metal, Inc., Milwaukee, has named the Davis Emergency Equipment Co., Melrose, Mass., as its safety tool distributor.

the News

M. A. Gibbons

Conoflow Corp., Philadelphia, has selected the Watts Co., Houston, for Cono Controls in that area.

Beaumont Birch Co., Philadelphia, has appointed the Ellman Equipment Co., Cincinnati, as its representative in that area.

New Companies

Industrial Models, N. V. (Holland), The Hague, will produce models of oil refineries and chemical plants for European and American markets.

Olin Mathieson Chemical Corp. has been formed through the merger of Olin Industries, Inc. and Mathieson Chemical Corp. Their combined assets total $5 million.

American Rocket Co. will conduct research and development on jet and rocket devices, at its Wyandotte, Mich., laboratory.

Mannix Gill Ltd., Canadian affiliate of J. B. Gill Co., Long Beach, Calif., will specialize in construction in the oil industry.

Columbia River Chemicals has been incorporated by W. R. McRae of Alberta, Canada. Capitalization is listed at $6.75 million. The firm plans to build an anhydrous ammonia plant near Pasco, Wash.

Ricklin Research Associates will offer consulting services in Providence, R. I., for the chemical industries.

Guarian Paper Co. will manufacture polyethylene film and polyethylene coated packaging material in Oakland, Calif.

New Facilities

Shell Oil Co. has constructed the first platforming unit in the San Francisco Bay area. The unit will

NOW 3 GREAT FEinc FILTERS

FOR *REALLY* CONTINUOUS FILTRATION

Easy or tough, your continuous filtration is *different*. It takes a lot of experience plus careful study of your specific problem to select and design the smoothest running, most economical filter. Filtration Engineers Inc. offers you more than 35 years of this kind of experience . . . backed by proved ability to deliver tailor-made filters at no more than standard costs.

The FEinc String Discharge Filter . . . the original string filter . . . handles all types of cakes . . . even thin soupy slimes. The strings lift the cake from the cloth cleanly, and eliminate common problems of smearing, blinding and blow-back. Cloths last longer, with less down-time for washing or replacements. Often it's the most economical filter for easy jobs as well as tough ones. Special features included submergence washing and compression dewatering.

The new FEinc horizontal filter, simple, trouble-free, is recommended for free-filtering materials such as coarse granules, or fibrous cakes. Countercurrent washing is available.

FEinc scraper filters, for standard problems, are quality built, with many special constructions, such as rubber covering, totally enclosed housings, etc. On filter at right, for instance, drum submergence can be varied at will from zero to 30%.

Ask today for full details or analyses . . . no obligation, of course.

STRING FILTERS

HORIZONTAL FILTERS

SCRAPER FILTERS

Filtration Engineers, Inc.

CUSTOM DESIGNERS AND MANUFACTURERS OF ALL TYPES OF CONTINUOUS FILTRATION EQUIPMENT

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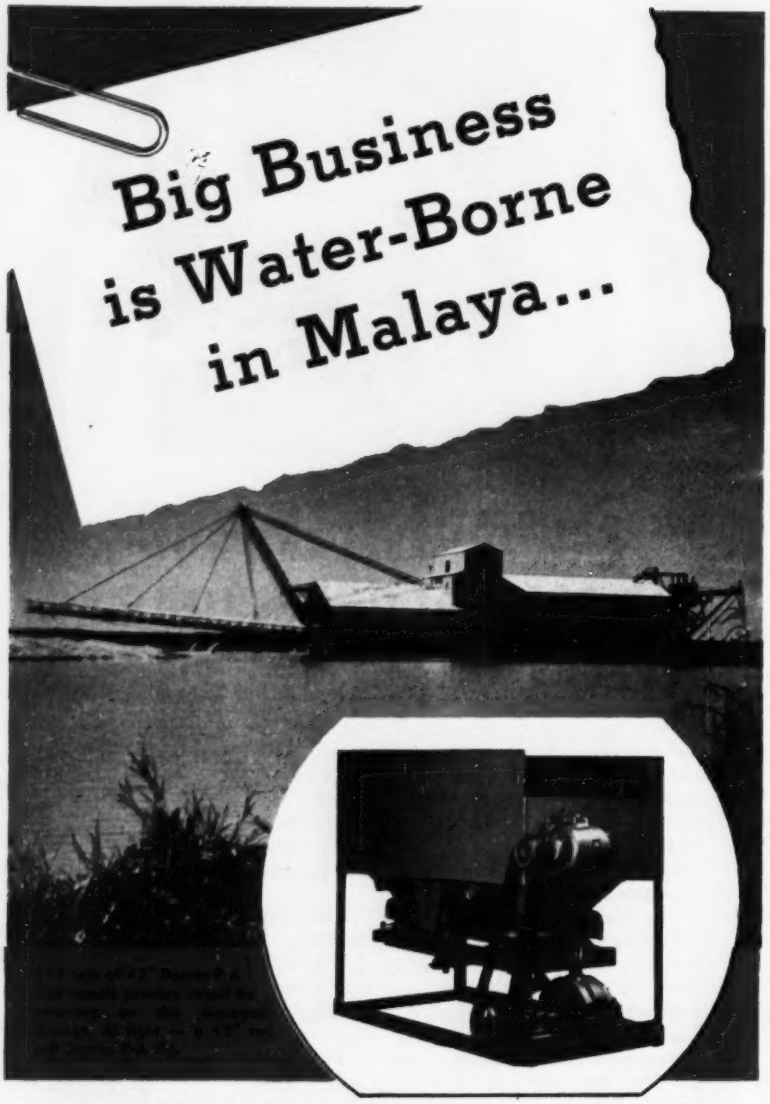
FEinc

43



Placer tin mining is big business in Malaya — source of better than a third of total world production. And dredging for the tin-bearing matrix is a big tonnage operation. For instance, the 304′ dredge pictured above can dig 480,000 cubic yards per month from 130 feet below water level.

The bucket line discharges matrix to a trommel screen where oversize waste is separated from minus ⅜″ feed for further processing. First step, and point of maximum tin concentration — fourteen batteries of Dorrco P-A Jigs, each comprising eight 42″ x 42″ cells. These units are compact and light in weight — important considerations in water-borne operations.

Tin recovery in Malaya may be of academic interest only to you. But, if you have problems involving any phase of the separation of finely divided solids in suspension — or ion-exchange — or fluidizing techniques... chances are that our worldwide organization can help you.

FIFTY YEARS 1904-1954

Better tools TODAY to meet tomorrow's demand

DORR

WORLD-WIDE RESEARCH • ENGINEERING • EQUIPMENT

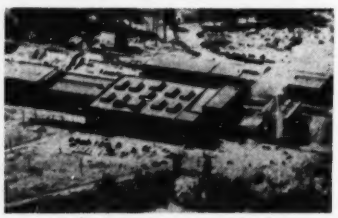
THE DORR COMPANY • ENGINEERS • STAMFORD, CONN.

Offices, Associated Companies or Representatives in principal cities of the world.

FIRMS . . .

produce high octane gasoline blending component from low octane petroleum stock at the Martinez refinery.

Emmet Technical Associates, New York, offers services in the field of technical control of industrial environments.



Arkell & Smiths, manufacturers of multiwall, coffee and specialty bags has acquired a fourth bag-making plant at Hudson Falls, N. Y.

Alloy Precision Castings Co. has leased the entire plant of the Industrial Metal Casting Corp., Cleveland.

Massachusetts Institute of Technology plans to construct a nuclear reactor for non-secret research in peacetime applications of nuclear energy.

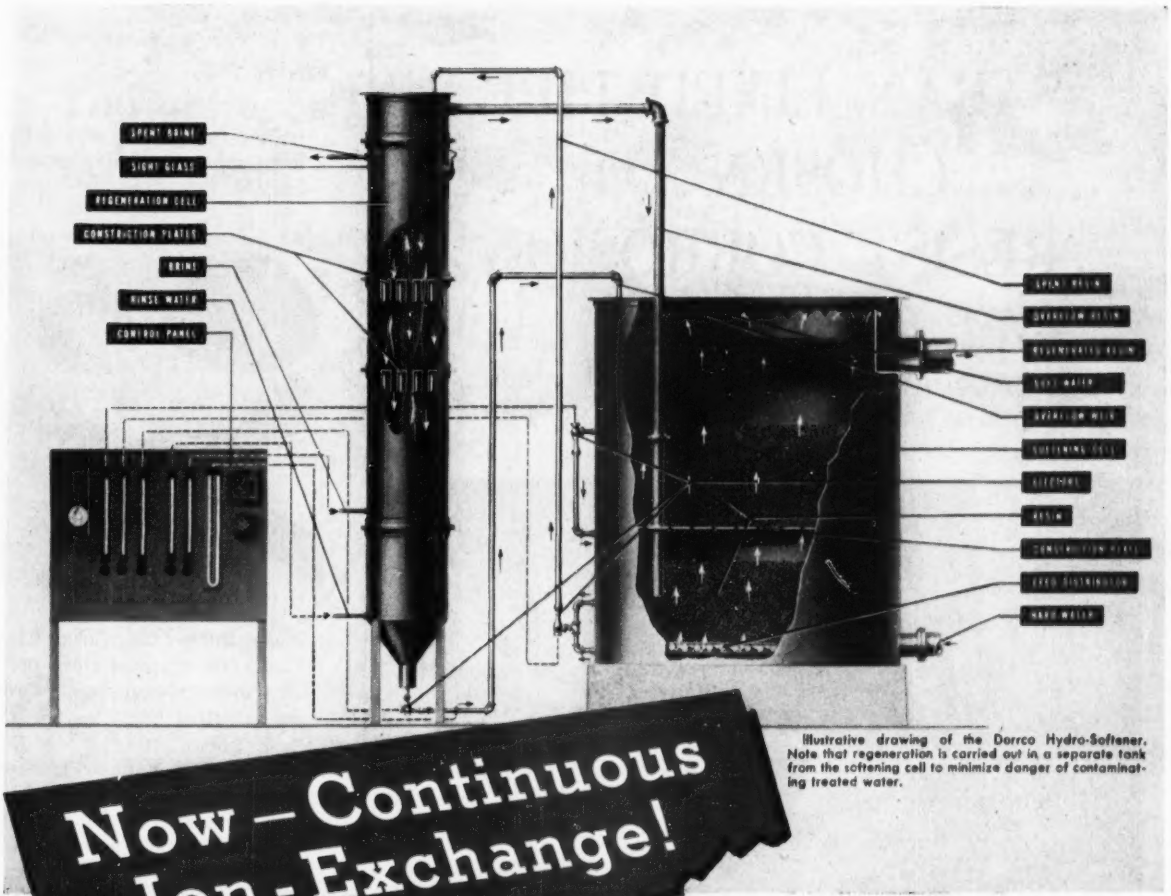
Carboline Co., St. Louis, Mo., has organized an adhesive division to conduct research in highly specialized applications.

Consolidated Testing Laboratory, Inc., West Hempstead, N. Y., has begun operations in chemical and metallurgical testing.

Rico Argentine Mining Co., Rico, Colo., has begun construction on its new sulfuric acid plant (capacity: 208 tons of acid/day).

Aerofin Corp. is now established in its new plant at 101 Greenway Ave., Syracuse, N. Y. The plant is devoted to the manufacture of extended heat-exchange surface.

Companhia de Petroleo da Amazonia, Manaus, Brazil, has awarded a $4 million contract



Illustrative drawing of the Dorrco Hydro-Softener. Note that regeneration is carried out in a separate tank from the softening cell to minimize danger of contaminating treated water.

Now—Continuous Ion-Exchange!

Dorrco Hydro-Softener Eliminates Batch Operation on Cation Cycle . . .

With the development of the Dorrco Hydro-Softener, ion-exchange has finally broken the bounds of batch operation. Used to soften municipal and industrial water supplies, the Hydro-Softener has definite operational and economic advantages over conventional systems. Exhausted resin is withdrawn from the softening cell, continuously regenerated with brine in a separate tank, and then returned to process. If alkalinity exists in the raw water, it too is removed by regenerating with a mixture of brine and acid. The net result is the production of a continuous supply of soft water at a constant quality.

Equally important, the basic principles of Hydro-Softener design show promise in many other fields as well. For example, cation resins can be used to recover metals from industrial wastes . . . anion resins will deacidify solutions of non-ionizable compounds.

And don't forget, in addition to the Hydro-Softener, Dorr manufactures a complete line of conventional Dorrco d-i* Systems. Maybe your ion-exchange application can "Go continuous". Maybe it can't. But either way, Dorr has the equipment and engineering ability to provide the correct approach to your problem. Address your inquiries to The Dorr Company, Stamford, Conn.

*Trade mark Reg. U.S. Pat. Off.

Better tools TODAY to meet tomorrow's demand

DORRCO

DORR

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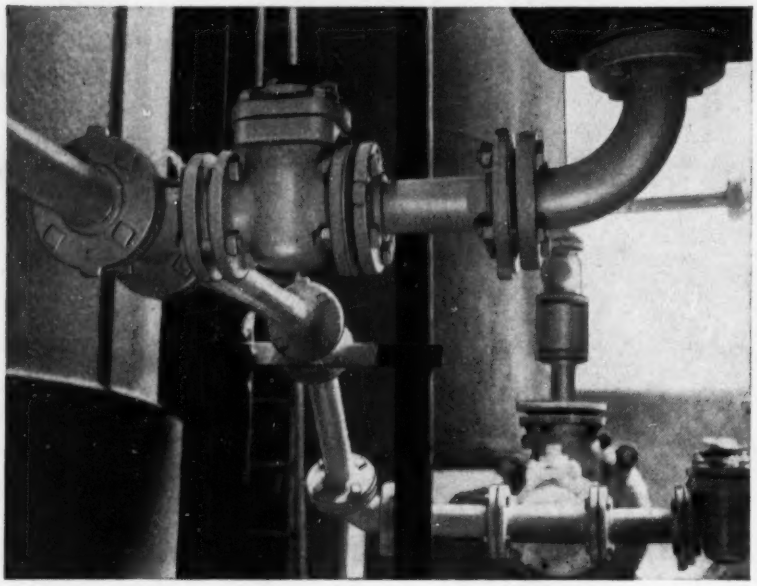
DOW

SARAN LINED PIPE CHOSEN TO RESIST CORROSION

And it has meant trouble-free service for this Illinois manufacturer, conveying hydrochloric acid at temperatures from 20° to 90° F.



The durable, corrosion-resistant lining of these 2½" saran lined pipe, fittings and valves have paid off for an Illinois manufacturer by eliminating costly shutdowns due to corrosion. And they've brought these additional advantages: 1. *Easy Installation* . . . saran lined pipe can be cut and threaded on the field using ordinary tools: no special equipment is needed! 2. *Added Safety* . . . the high-pressure strength of this steel-clad pipe eliminates danger caused by bursting pipe! 3. *No Leakage* . . . saran lined pipe, fittings and valves form snug, leak-proof joints!

If your operation requires the conveying of corrosive liquids, investigate saran lined pipe, fittings and valves. For further information contact The Saran Lined Pipe Company. THE DOW CHEMICAL COMPANY. Midland, Michigan.

RELATED SARAN PRODUCTS—Saran rubber tank lining • Saran rubber molding stock • Saran tubing and fittings • Saran pipe and fittings.

Saran Lined Pipe Company
2415 Burdette Ave., Ferndale 20, Michigan

Please send me a copy of your catalog on saran lined pipe, fittings and valves.

Name_____ Title_____

Company_____

Address_____

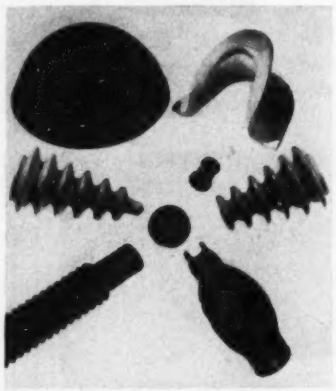
City_____ State_____

SP 1162A

you can depend on DOW PLASTICS DOW

FIRMS . . .

for the construction of a petroleum refinery to Southwestern Eng. Co.



Stillman Rubber Co., Culver City, Calif., has organized a new polyvinyl division to supply polyvinyls for industrial use.

Ashland Oil & Refining Co. has awarded a contract to Catalytic Construction Co. for a 6,000 b/d houdriformer unit.

Fluor Corp. of Canada, Ltd., Toronto, will open a Calgary office in the Oil Exchange Bldg.

Dan River Mills, Inc. has opened new warehousing facilities in Los Angeles to serve 11 Western states.

Foxboro Co., manufacturer of instruments, has completed its Pittsburgh, Pa., plant facilities.

Bigelow-Sanford Carpet Co., Inc., has acquired the assets of the LeConte Plastics Co., Inc.—producer of reinforced plastics.

E. I. duPont de Nemours & Co., Inc., plans to build a research laboratory for its film dept. in Wilmington.

American Enka Corp. has begun construction on a research building to be located near its Enka, N. C., rayon plant.

U. S. Stoneware, Akron, Ohio, has opened a direct factory sales office in Houston, Texas.

You gotta be first... to be best!*

*25 years ago, Alloy Fabricators started to build Stainless Steel, Monel, Inconel, Nickel and Aluminum Process Equipment. With this experience, naturally, they're your *best bet today!*

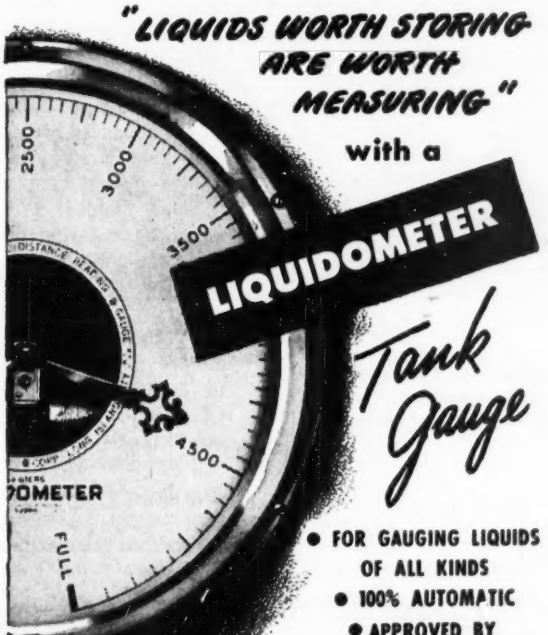
It's Still Our Only Business — And We Mind It Well!

ALLOY FABRICATORS

DIVISION OF CONTINENTAL COPPER AND STEEL INDUSTRIES, INC.

PERTH AMBOY, NEW JERSEY

"LIQUIDS WORTH STORING ARE WORTH MEASURING" with a LIQUIDOMETER Tank Gauge



- FOR GAUGING LIQUIDS OF ALL KINDS
- 100% AUTOMATIC
- APPROVED BY UNDERWRITERS' LABORATORIES

WRITE FOR COMPLETE DETAILS

THE LIQUIDOMETER CORP.
36-29 SKILLMAN AVE., LONG ISLAND CITY 1, N.Y.

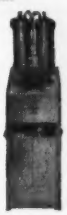
SUPER HIGH PURITY WATER

by the trouble-free magic of ion exchange

No "~~boil-outs~~" No "~~filter-ators~~" No ~~ions~~ No ~~heat~~ or ~~steam~~ power

Penfield Mono-Column Demineralizer Model M-100. Purity of effluent: less than 2 ppm. Flow rate: 60-90 gph. Dimensions: 1½' x 2' x 7'. Features inspection window that allows easy inspection of crucial middle distribution system.

Penfield Mono-Column Demineralizer Model MA-1000. Purity of effluent: under 1 ppm. Flow rate: 1000-1200 gph. Dimensions: 2' x 5' x 5½'. Features automatic shut-off and signaling devices and fully automatic regeneration system.



Penfield Dual-Column Demineralizer Model UL-60. Purity of effluent: 5 to 10 ppm. Flow rate: 75-100 gph. Dimensions: 2' x 2' x 4½'. Features self-contained stainless steel control cabinet in which regenerant tanks are stored.

READY TO OPERATE ON ARRIVAL!

Available in a wide variety of mono-and multi-column models (flow rates from 10 to 10,000 gph), all Penfield Demineralizers come equipped with regenerant tanks and all necessary gauges, flow meter, conductivity meter, etc. On arrival at site, simply connect the completely "packaged" unit to service lines and start receiving super high purity Penfield demineralized water.

Any model Penfield Demineralizer may be secured with automatic shut-off and signaling devices and a fully automatic regeneration system. Special control systems for the automatic maintenance of the purity of storage tank water supplies also available.

Write for fully descriptive catalog.

PENFIELD M'FG. CO., INC.

19 High School Ave., Meriden, Conn.

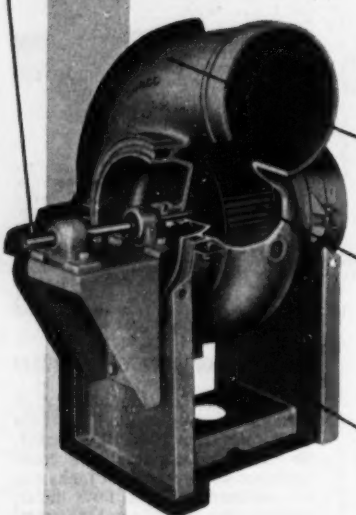
Filters · Softeners · Degasifiers · Demineralizers

PENFIELD "PLANNED PURITY" PAYS!

Wherever corrosive fumes are exhausted,

specify the complete new line of acidproof, all-metal DURCO **exhaust fans**

When you know that fumes to be exhausted are corrosive, why install anything less than a fan which will handle them *permanently?* Newly designed DURCO exhaust fans are all metal—Duriron casing with Durimet 20 multi-blade rotor—for complete corrosion resistance. They're 30% lighter than previous models. They're lower priced and save the cost of down-time and labor for repair or replacement. Full facts in Bulletin F/1.


BELT DRIVE.
Adaptable to varied applications.
8 STANDARD DISCHARGE ARRANGEMENTS
Also available for angular discharge.
DURIRON CASING.
All metal sections for complete corrosion resistance.
DURIMET 20 MULTI-BLADE ROTOR.
High corrosion resistance and capacity increase of over 50%.
FABRICATED STEEL BASE.
Weight reduction with greatest strength.

DURCO

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THE DURIRON COMPANY, Inc., Dept. CE, Dayton, Ohio

Please send Bulletin F/1 on DURCO B-124 Fans.

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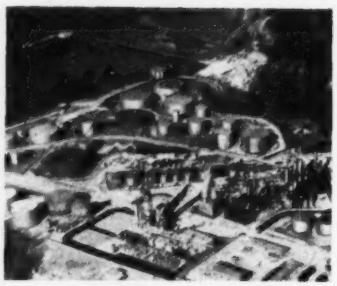
FIRMS . . .



Shell Oil Co. of Canada

The growing market for high octane gasoline, fuel oils, lubricants and asphalt products in British Columbia has prompted a $15 million expansion at Shell Oil's Shellburn refinery near Vancouver, B. C. Plant extensions have increased crude oil production from 9,000 to 15,000 b/d.

Hercules Powder Co.'s synthetic resins plant, Burlington, N. J., is nearing completion.

American Petroleum Institute, N. Y., has inaugurated a research project to study various nitrogen compounds in crude oil.

Westinghouse Electric Corp, plans to build a multi-million dollar sound laboratory and test center in Sharon, Pa.

Sure Seal Corp.'s $1.5 million chemical de-waxing plant, near Salt Lake City, is now in operation.

Food Machinery & Chemical Corp.'s multi-million dollar anhydrous ammonia unit in So. Charleston, W. Va., is nearing completion.

Martin Paper Products, Ltd., plans to construct a $1 million corrugated box plant in Queensboro, B. C.

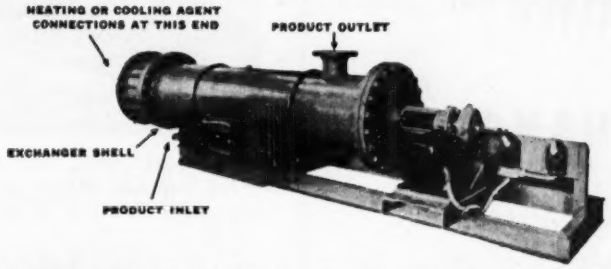
Clorox Chemical Co. has opened a manufacturing plant at Seattle to produce bleach and household disinfectant.

General Electric Co.'s two-story, $1 million clinic, located at Schenectady, has been completed.

DO YOUR PROCESS HEAT EXCHANGERS FOUL UP?

. . . THEN USE THE Paracoil

AUTOMATIC SELF CLEANING HEAT EXCHANGER



Specifically designed for those heat transfer processes involving the continuous heating or cooling of viscous materials or fluids that normally deposit heat insulating films on exchanger tubes or autoclave surfaces.

With the Paracoil Self Cleaning Heat Exchanger all product deposits are automatically removed from exchanger tubes by motor driven Scraper Surfaces moving continuously or at intervals determined by needs of the specific process.

OBTAIN . . .

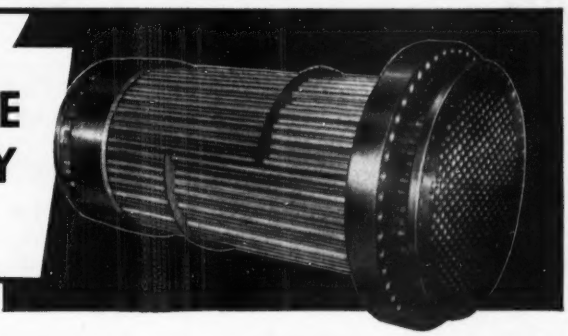
- **Maximum Production** — No plant shutdown for cleaning!
- **Maximum Heat Transfer** — Tube Surfaces are always clean!
- **A Better, More Uniform Product** — Conditions at their best!

Particularly adapted to the handling of vegetable oils, fats, waxes, pastes, creams. Write for Bulletin HE-100. We invite your inquiries.

DAVIS ENGINEERING CORPORATION

1064 EAST GRAND STREET. ELIZABETH. N. J.

INSIDE STORY



Designed *right*...built *right*...that's why Downingtown heat transfer equipment works extra well in the process line.

Designed by experienced engineers ...expert at solving specific heat exchanger problems.

Built by craftsmen skilled at holding extra-tight tolerances on tube fit in tube hole...tube fit in baffle hole... alignment of baffles...and bundle fit in shell—details which help assure efficient performance.

Fabricated from various grades of Carbon Steel, Stainless Steel, Stainless and Nickel Alloy Clad Steel, Nickel, Nickel Alloy, Aluminum, Copper Alloy, Ampco 8, Karbate, Haveg or other material. Built to ASME code where necessary.

Send for additional information on heat exchanger design.

Downingtown Iron Works, Inc.

HEAT EXCHANGERS—TOWERS—PRESSURE VESSELS
STORAGE TANKS—STEEL AND ALLOY PLATE FABRICATION

Downingtown, Pennsylvania

New York Office: 52 Vanderbilt Avenue, New York 17, N. Y.

DIVISION OF: Pressed Steel Tank Company

Manufacturer of Hackney Products
Milwaukee 14, Wisconsin

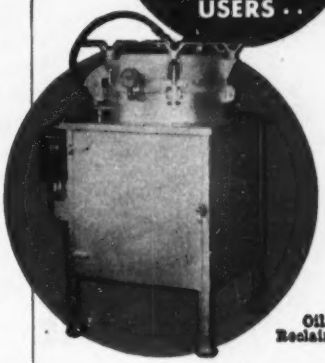
CONTAINERS AND PRESSURE VESSELS FOR GASES, LIQUIDS AND SOLIDS

for *Low* VACUUM PUMP MAINTENANCE COSTS and BETTER VACUUM . . .

it's the

HILCO OIL RECLAIMER

for VACUUM PUMP USERS . .



Oil Reclaimer

A simple, economical and efficient method of restoring contaminated lubricating and sealing oil to the full value of NEW OIL. The HILCO will produce and maintain oil free of solids, gums, water and gases in a continuous, all-electric, automatic operation.

Be SURE of clean oil in your HIGH VACUUM PUMPS

HILCO OIL RECLAIMER SYSTEMS . .

- ***WRITE FOR COMPLETE DETAILS IN THE FREE BULLETIN***

Recommendations at no Obligations

131 W. Fourth St., Elmira, N. Y.

*FIRST LINE

Extended-Surface

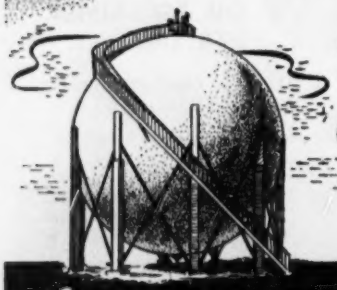
HEAT EXCHANGERS

ASK THE AEROFIN MAN

Specify Aerofin and you specify high efficiency, long service life and low maintenance and service costs.

Take advantage of Aerofin's unequalled experience, production facilities, and materials-testing and design research—of Aerofin's complete engineering service at the plant and in the field.

* *Aerofin makes extended heat surface exclusively — not as a by-product, not as a side-line.*



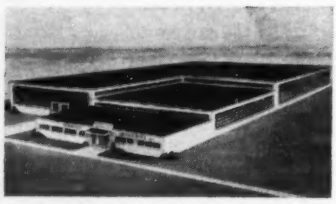
Throughout the Chemical Industry—

Aerofin units do the job Better, Faster, Cheaper

AEROFIN CORPORATION 101 Greenway Ave. Syracuse 1, N. Y.

Aerofin is sold only by manufacturers of fan-system apparatus. List on request.

FIRMS . . .



Schmieg Industries, Inc., Detroit, has increased its plant mfg. capacity by 60%.

Swift & Co. has installed a new refining unit for its acidless tallow at the Dallas, Texas, plant.

Chemical Projects Associates has leased executive offices in New York's RCA Bldg., for economic consulting services.

Arthur D. Little, Inc. has acquired the research and development div. and laboratories of the Merrill Co., San Francisco.

Monsanto Chemicals Ltd., London, plans to construct a major plant to manufacture maleic anhydride by direct oxidation of benzene.

Standard Oil Co. (Indiana) has organized a transportation and supply dept. as a new main branch of its organization.

Lion Oil Co. will soon see the completion of its new dry ice plant in Louisiana, constructed by the Girdler Co., Louisville, Ky.

Central Fiber Products Co., Inc., has broken ground in Omaha for a new box plant ($4.5 million investment).

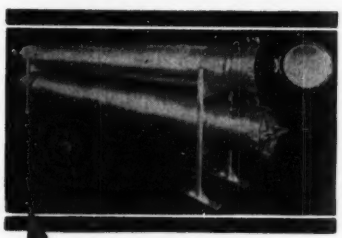
R. M. Hollingshead Corp., Camden, N. J., has begun construction of a 60,000 sq. ft. branch in Sunnyvale, Calif.

E. I. du Pont de Nemours & Co., Inc., plans to expand facilities for the manufacture of "Teflon" tetrafluoroethylene resin at the Washington Works, W. Va.

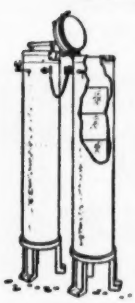
McMillen Feed Mills, div. of Central Soya Co., Inc., plans to con-

A DEPENDABLE SOURCE FOR INERT GAS

DRY ICE CONVERTERS



No Operating Costs! Easily Cleaned!



Dry Ice Converters are A.S.M.E. code pressure vessels especially adapted to charging with full 50-lb cakes of solid CO_2. They may be located any place in a plant, connected by pressure piping to use area for the gas.

They require no fuel, no electricity, no refrigeration. There are no operating costs! Because they are full opening, they are easily inspected and cleaned. They are ideal for either stand-by or continuous use. A variety of sizes are available for either horizontal or vertical installation.

Write for price list and folder giving complete information

DRY ICE CONVERTER CORP. TULSA, OKLAHOMA

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You, too, can be assured of top pumping performance. Follow the example of Littleford Bros., Inc., Cincinnati. They know what Viking pumps can really do after incorporating over 20,000 of them on their road construction and maintenance equipment. Service includes handling hot or cold road oils, tars, asphalt, cutbacks and emulsions.

If you are looking for dependable pumps as original equipment, or for individual performance, follow Littleford's example and learn more about Vikings. Write for Bulletin 545C.

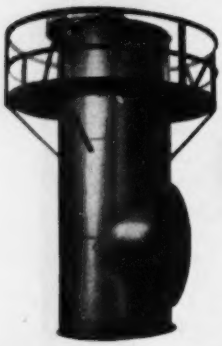
VIKING AN HONORED NAME IN PUMPING

See Our Catalog In SWEETS

VIKING PUMP COMPANY
CEDAR FALLS, IOWA

STAINLESS STEEL

FOR METAL PRODUCTS CONTACT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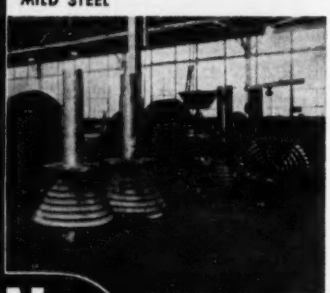
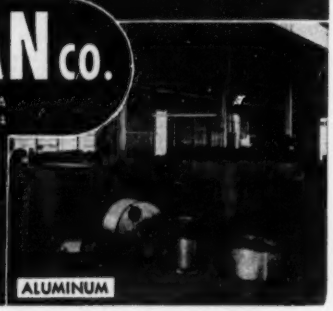
You can save valuable time and money by taking your metal fabricating problems to an experienced team right off the bat . . . and that's BOARDMAN! More than 43 years of designing, engineering and manufacturing every type of metal product—from carbon steel, stainless steel, clad steels, aluminum and wrought iron—make BOARDMAN qualified to handle your fabricating jobs from drawing board to flat car.

MILD STEEL

THE BOARDMAN CHALLENGE

Whatever your metalcrafting needs may be, let our Chief Engineer fly to your plant for on-the-spot consultation, at our expense. For literature, quotations or immediate action, write, wire or telephone TODAY!

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OKLAHOMA CITY, OKLAHOMA
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FIRMS . . .

struct a modern plant in Chattanooga for soybean processing and feed manufacturing.

Farrel-Birmingham Co., Inc., has completed and put into operation a new process laboratory at Ansonia, Conn., for plastics experimentation.

Eclipse Fuel Eng. Co., Rockford, Ill., plans to build a new plant in Toronto for its Canadian subsidiary.

Merck & Co., Inc., chemical division has established a regional sales office in Atlanta, Ga.

Bureau of Mines plans to open a Morgantown, W. Va., experiment station for research in synthetic liquid fuels.

Imperial Sugar Co., Sugar Land, Tex., plans a $3 million expansion program during the next six years.

Nat'l Lead Co. has opened the new headquarters building of its experimental test station in Sayville, L. I.

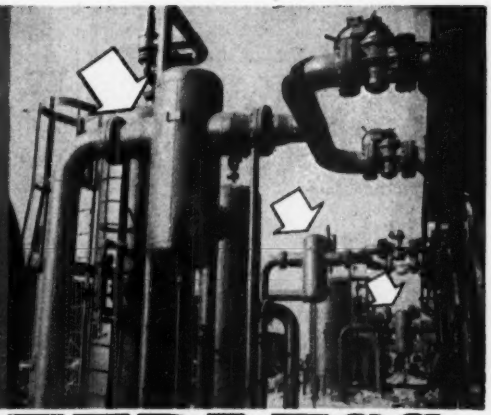
Rhodia, Inc., N. Y., has established an engineering service section within its industrial Alamask Readorant division.

Southland Paper Mill, Inc., Lufkin, Tex., will install a third newsprint manufacturing machine.

Pittsburgh Coke & Chemical Co. has opened a protective coatings office in Dallas, Tex.

Shell Chemical Corp. has purchased an alcohol mfg. and denaturing plant in Culver City, Calif. from Lac Chemicals, Inc.

FOR THE ANSWER TO SEPARATION PROBLEMS IN CHEMICAL PLANTS



SEE PEERLESS

Shown above are five Peerless line separators on outlet lines from cooling tower efficiently extracting entrained liquid. Performance Guaranteed. Call Peerless to solve your entrainment problem.

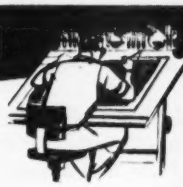
PEERLESS MFG. CO.

PEERLESS MANUFACTURING CO.

P. O. BOX 7193 ★ DALLAS, TEXAS ★ DIxon-8431

REPRESENTATIVES IN ALL PRINCIPAL CITIES

FOUNDRY SERVICE



Geared to the Chemical Industry

Service Foundry is ably staffed with mechanical and metallurgical engineers to insure proper control and close inspection of all foundry work. All types of industrial and marine castings in steel, iron, bronze and aluminum. Radiographic and magnaflux testing. Large capacity and high precision machine tools for all types of machine work.

We are prepared to meet your specifications and invite your inquiry.

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Always SWIVEL and ROLL

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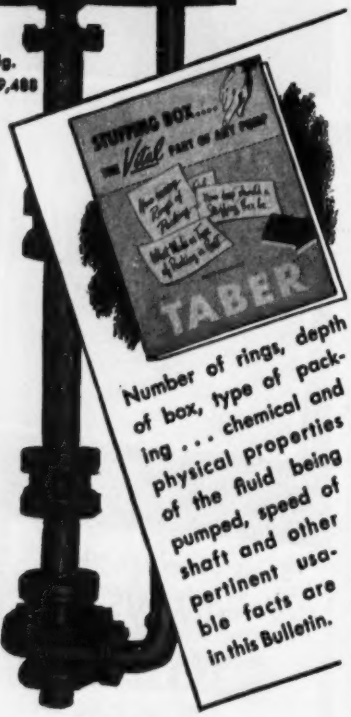
PUMP STUFFING BOXES

INFORMATION suggesting solution of common stuffing box difficulties; available in newly revised BULLETIN S-147

Fig. 19,488



Number of rings, depth of box, type of packing . . . chemical and physical properties of the fluid being pumped, speed of shaft and other pertinent usable facts are in this Bulletin.

WRITE on business stationery for your copy of Bulletin S-147.

TABER PUMP CO. (Est. 1859)
294 ELM ST. • BUFFALO 3, N. Y.

Fig. 6041

E-770

TABER

FIRMS . . .

Meyer Chemical Co., Detroit, will open a Sao Paulo, Brazil, lab to produce various pharmaceuticals.

Pennsylvania Salt Mfg. Co. will add two new plants at Delaware, Ohio, and Chicago Hts., Ill., for its chemical specialties div.

Pittsburgh Plate Glass Co. has taken over the plant site formerly owned by Porcelier Mfg. Co., Greensburg, Pa.

Godfrey L. Cabot, Inc., Boston, has opened its new $1,790,000 mill at Willsboro, N. Y. for the production of Wollastonite,

Northwest Pulp & Power Co. plans to construct a $30 million pulp mill near Edmonton, Alberta.

The Glidden Co. has integrated five major industrial-agricutural operations into a single Chemurgy Division.

Canadian Schenley Ltd., No. Vancouver, B. C., plans to build a new $7 million distillery.

E. I. du Pont de Nemours & Co., Inc. plans to construct a new plant in Louisville, Ky., to produce "Freon-22" monochlorodifluoromethane.

Chemical Lime Co., Baker, Ore., plans to build a new lime plant —calling for installation of three rotary kilns.

Monsanto Chemical Co. has established a research group to conduct customer service application studies with polyester resins.

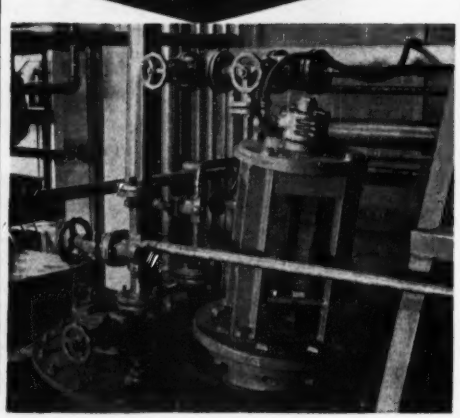
Girdler Co., Louisville, Ky., has begun the erection of a major addition to its catalyst plant.

WALWORTH VALVES on the job in the chemical industry

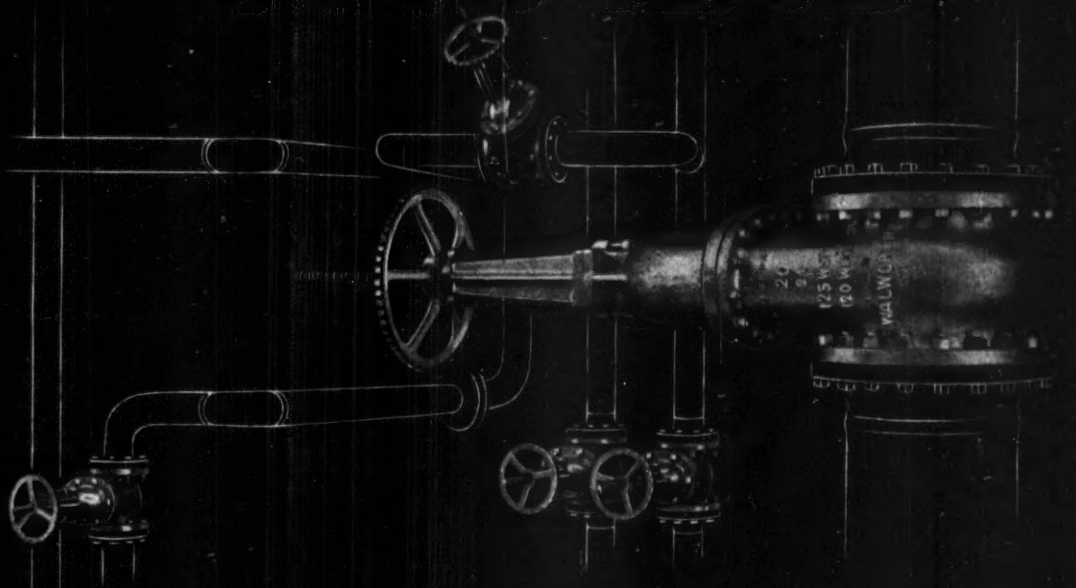
In addition to the valves described on the facing page, Walworth manufactures a wide range of valves and pipe fittings used extensively in chemical plants.

At a large Pennsylvania chemical plant* these Walworth Stainless Steel Gate Valves are on a separator used for extracting an inorganic compound. Other Walworth products include valves and pipe fittings of bronze, iron, steel, and special alloys. For complete information, see your Walworth distributor, or write: Walworth Company, General Offices, 60 East 42nd Street, New York 17, New York.

*Name on request



WALWORTH



IRON BODY WEDGE GATE VALVES

Better because ...**The entire valve, from handwheel to seat rings, is ruggedly constructed to withstand rough and frequent usage. Body, bonnet, and yoke are sturdy castings with large radius fillets. Dimensions and drilling of end flanges are in agreement with American Cast Iron Flange Standards. Stiffening ribs connect end flanges with the body neck to maintain a rigid connection with piping.**

A wide range of Walworth Iron Body Wedge Gate Valves is available—through your Walworth Distributor—from which you can choose the right type to meet your most exacting conditions. Saddle-type valves as small as ¼-inch; low pressure valves for water and gas pipelines up to 36 inches.

Whenever you need valves and fittings, choose from complete lines—in a variety of metals—manufactured by Walworth. For more information, see your Walworth Distributor or write: Walworth Company, General Offices, 60 East 42nd Street, New York 17, N. Y.

Walworth No. 726F OS&Y (Outside Screw and Yoke) Iron Body Wedge Gate Valve. OS&Y valves are recommended for services where it is desirable that the line fluid does not come in contact with the stem threads. Note the swing-type gland-eye-bolts for easy repacking. Sizes 2 to 30 inches.

WALWORTH

Manufacturers since 1842

valves . . . pipe fittings . . . pipe wrenches

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In grain mills . . . it pays to install trouble free

ALLEN-BRADLEY MOTOR CONTROL

A-B Quality

The Sign of Quality in Motor Controls

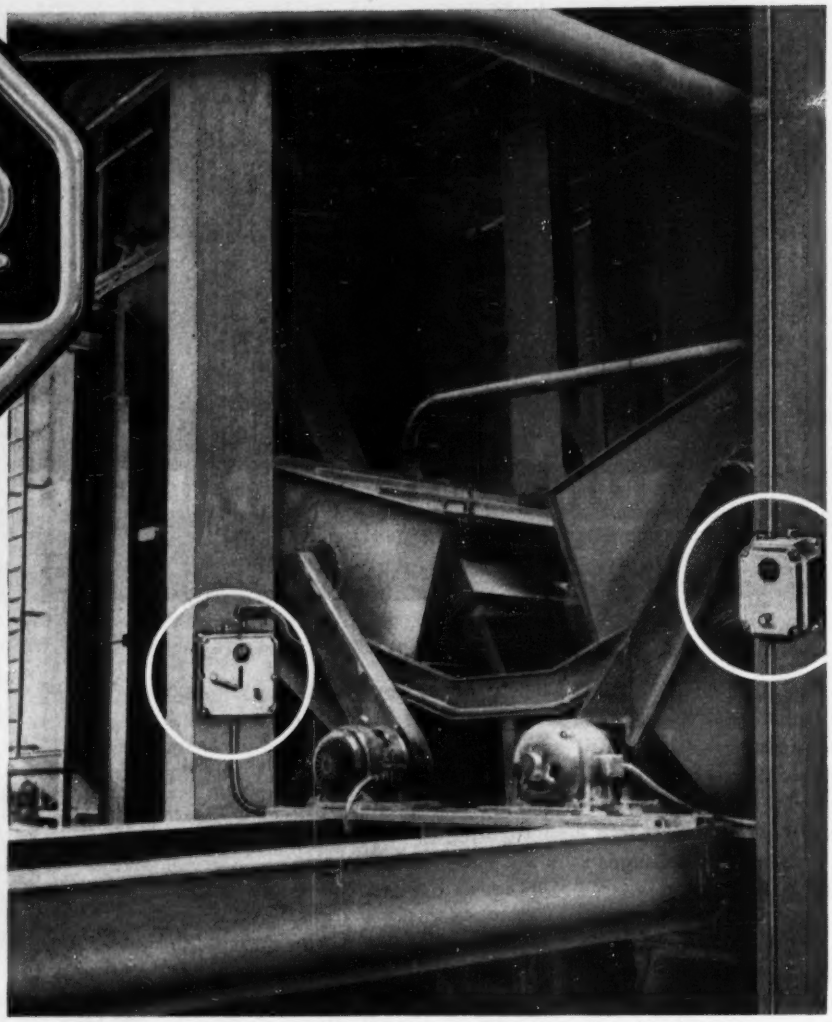
Typical Enclosures for Various Operating Conditions

Bulletin 709 Solenoid Starter in NEMA 7 Enclosure.

Bulletin 713 Combination Starter in NEMA 7 Enclosure.

Bulletin 709 Solenoid Starter in NEMA 8 Enclosure.

Bulletin 609 Manual Starter in NEMA 4 Enclosure.



Vibrating screens in Vermont Chow plant, operated by Allen-Bradley solenoid starters.

It pays out in greater safety, lower maintenance, and fewer shut downs, to use the correct enclosure for each motor starter.

Allen-Bradley solenoid motor starters and bolted enclosures are a time and money-saving combination, since the double break, silver alloy contacts require no cleaning, filing, or dressing. Furthermore, Allen-Bradley solenoid starters have only ONE moving part . . . therefore, virtually no chance to go wrong. Thus, inspection is necessary only at rare intervals—and inspection time is saved.

Starters are available in enclosures for wet locations, hazardous gas locations, hazardous dust locations, corrosive atmospheres, and where both corrosive and explosive gases are present.

Allen-Bradley starters won't cost you less when you are buying—but they will operate for less when installed.

Allen-Bradley Co., 1337 S. First St., Milwaukee 4, Wis.
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Here's A **Single Source** of **Supply**

For so Many of Your Process Needs

MIXERS & AGITATORS

Types: turbine, propeller, paddle, anchor, finger, screw, ribbon, gate. Service: For all single or multi-phase processes involving liquids, solids, pastes and gases.

TANKS & PRESSURE VESSELS

Materials: carbon steel, the stainless steels, nickel, monel, inconel, hastalloy, clad steels. Construction: ASME Code

REACTORS & PROCESS UNITS

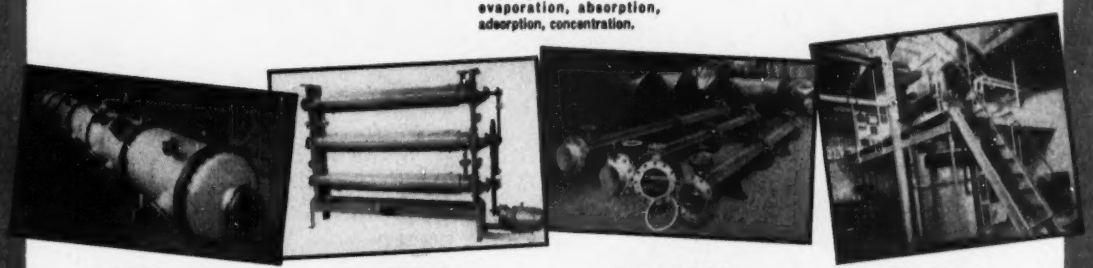
Processes: chlorination, fermentation, saponification, hydrogenation, nitration, sulfonation, polymerization, digestion, esterification, other organic syntheses. Operations: crystallization, heat transfer, extraction, drying, distillation, evaporation, absorption, adsorption, concentration.

HEAT EXCHANGERS

Types: shell and tube, floating head, fixed tube sheet, U-band key fittings.

EVAPORATORS

Types: forced circulation, natural circulation, multiple-effect.



DISTILLATION COLUMNS

Types: bubble cap, packed, "turbogrid", special types.

SPECIAL EQUIPMENT

Like chillers, crystallizers, paste mixers, cone and ribbon blenders, post mixers, vacuum pan dryers, paint reducing tanks.

CUSTOM FABRICATION

The Newark Plant of I★P★E is one of the largest and best equipped in the East. You get precision machine work and highest quality welding on everything from a simple tank to a complex mechanical unit. Facilities list available on request.

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Scope: From process and equipment design, to fabrication and construction, to initial operation.

If you're in on the purchase specifications of plants and equipment, you know well the advantages of dealing with a *single source of supply* . . . one point of responsibility, uniformity of materials, similarity of parts. Your entire plant or process unit fits together better, runs more smoothly and gives you trouble-free service.

From the fabrication of vessels, agitators or precision machinery . . . to the engineering, design and construction of process units or entire industrial chemical plants . . . . I* P* E offers you the *complete* service. Whatever your needs are, you'll get more help at lower cost from I* P* E. Write or 'phone today.

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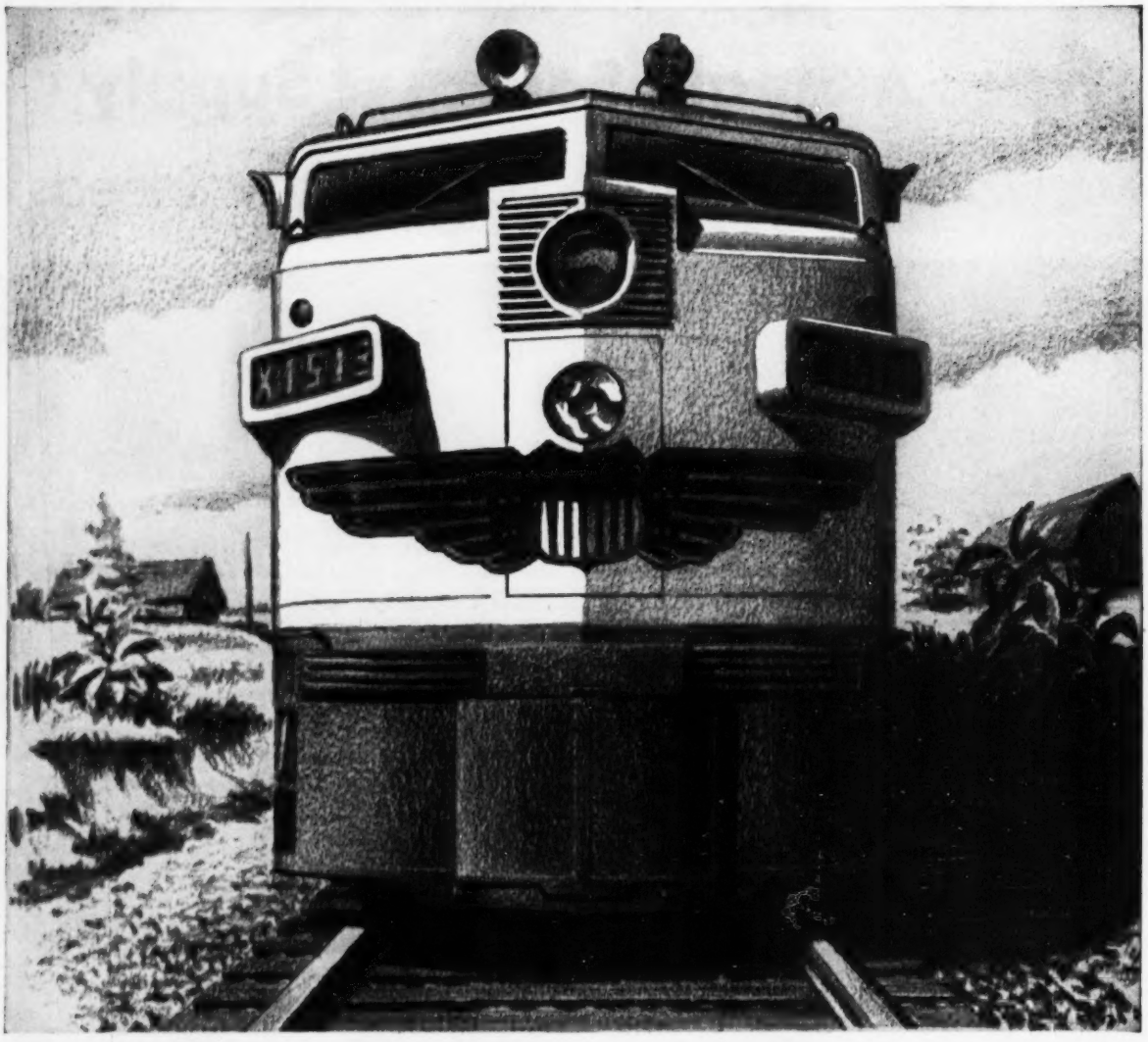


Here's where heat and corrosion prove metal...and metallurgists

For castings subject to High Fluctuating Temperatures . . .

Waukesha No. 321 Titanium Stabilized Stainless Steel

Supercharger inlet ports in giant railroad diesels demand castings of unusual characteristics. They must be high in corrosion resistance, and must maintain this resistance under abnormally high temperature fluctuations. In addition, close tolerances demand easy machinability.

This is the kind of problem that naturally comes to Waukesha Metallurgists for laboratory solution. Waukesha No. 321 Stainless Steel with *titanium*, with carefully controlled modifications, offered a solution. Its effective use in castings requires a high degree of knowledge and skill both in formulation and in production, but Waukesha has succeeded in casting it for such critical uses as trays and conveyor parts for heat treating furnaces and other high temperature needs. Its adaption to G-E Supercharger inlet ports is another example of Waukesha's experience in serving industry with the more difficult alloys.

Have You a Castings Problem?

Take this opportunity to prove Waukesha's advanced metallurgical service — to your profit! Send us a pattern for sample casting. Or write for booklets containing current data on Waukesha Stainless Steel and "Waukesha Metal".

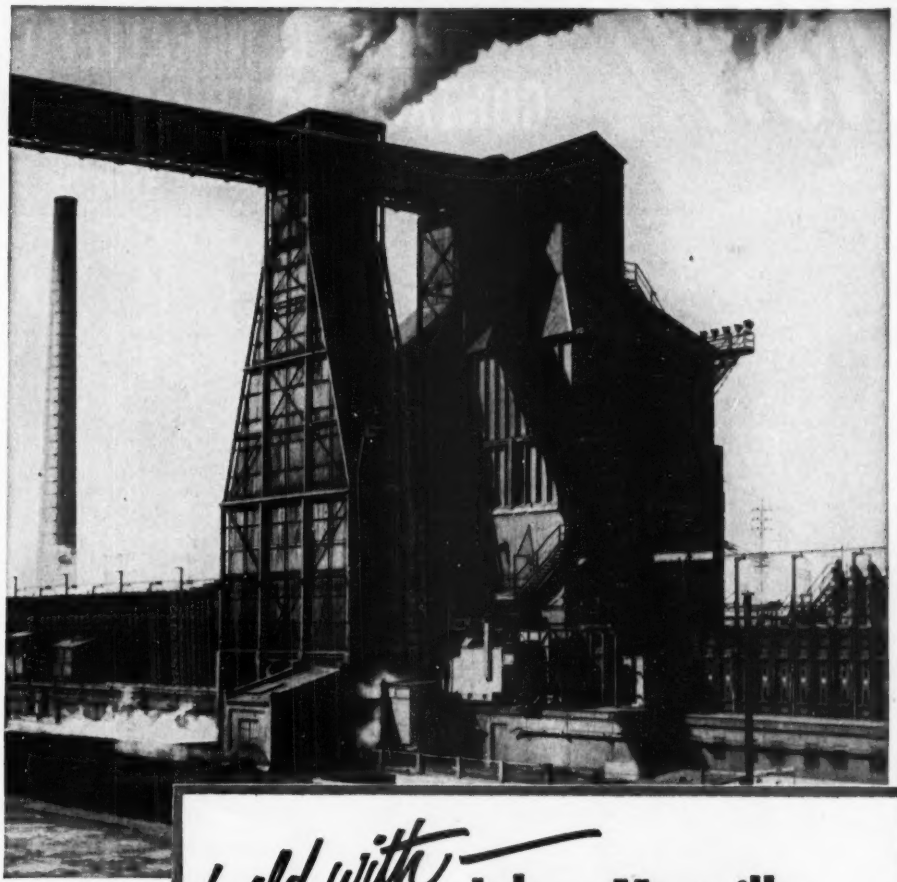
call *Waukesha* first . . .

WAUKESHA FOUNDRY CO.

5402 LINCOLN AVE., WAUKESHA, WISCONSIN

For Metallurgical Aid in Every Corrosion Resistant Alloy

No costly maintenance problem here



So severe are the steam and fume conditions in this coke quencher station, that the heavy structural steel framing is on the *outside*, protected by J-M Corrugated Transite

build with Johns-Manville Corrugated Asbestos Transite

- Large sheets go up quickly
- Easy to fasten to steel
- Easy to nail to wood
- Easy to saw
- Easy to drill

For permanent, maintenance-free construction, plus protection from fire, rot and weather

YOU SAVE MONEY on construction and maintenance when you build with J-M Corrugated Transite®. Corrugated Transite comes in large sheets that require a minimum of framing . . . permit fast economical construction of maintenance-free industrial, commercial, institutional and agricultural buildings.

Made of asbestos and cement, Corrugated Transite is practically indestructible. It never needs paint or special treatment to preserve it . . . it's fireproof, rotproof and weatherproof. Corrugated Transite is also used increasingly for smart interiors . . . the streamlined corrugations and attractive shadow lines that give it such unusual architectural appeal for exteriors offer unlimited interior design possibilities.

Investigate Johns-Manville Corrugated Asbestos Transite and learn how you can build quickly and easily . . . have an attractive, long-lasting, trouble-free structure regardless of size or purpose. For complete details write Johns-Manville, Box 158, Dept. **CE**, New York 16, New York. In Canada write 199 Bay St., Toronto, Ontario.

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NOW! FISCHER & PORTER'S COMPLETE CENTRALIZED CONTROL INSTRUMENTATION

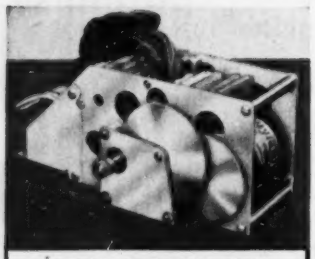
Includes Data Reduction Systems

Right from the day you recognize the need, Fischer & Porter Company will plan with you for complete process instrumentation. One source, one contract—will take your plans from first stages through to installation.

Fischer & Porter offers you comprehensive control coverage—the finest standard and miniature instruments for most variables... complete design, engineering and construction facilities for any type of panel or cubicle... experienced technical assistance... *and* data reduction and automation systems.

And F & P complete service costs less, because of the complete handling from beginning to end in one plant.

Use all the advantages of automation. Write, call or wire today for complete information and engineering assistance.



F & P is first with a Data Reduction and Automation Division. Now available is a new digital converter, which provides completely automatic logging from sensing elements to coded or tabulated digital data output.

complete process instrumentation

FISCHER & PORTER CO.

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FP

Measuring, Recording, and controlling instruments—Control Panels—Data Reduction Systems—Contract Instrumentation Research—Chlorination Equipment—Glass Specialties.

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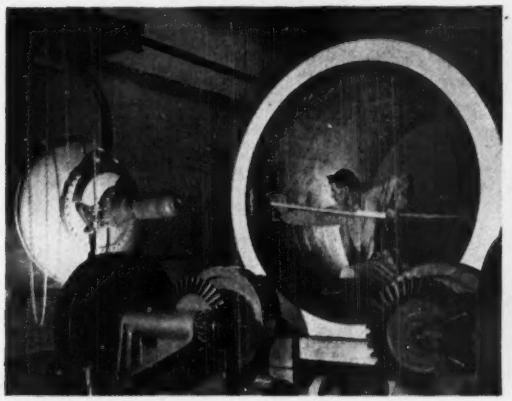
Process Equipment that meets *TODAY'S* Requirements

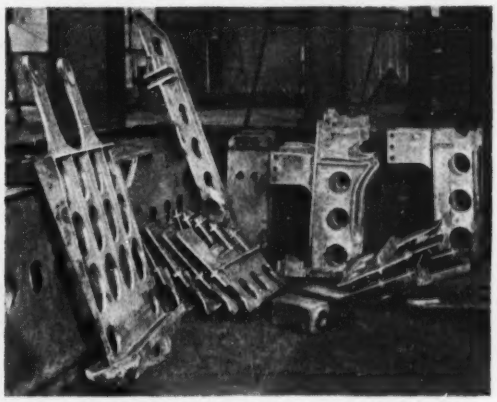
B&W Accumulators • Alloy Castings • Hollow Forgings

The constant progress being made within the process industries demands the utmost of the engineers responsible for the dependability, efficiency and economy of the equipment that serves today's process industries' requirements.

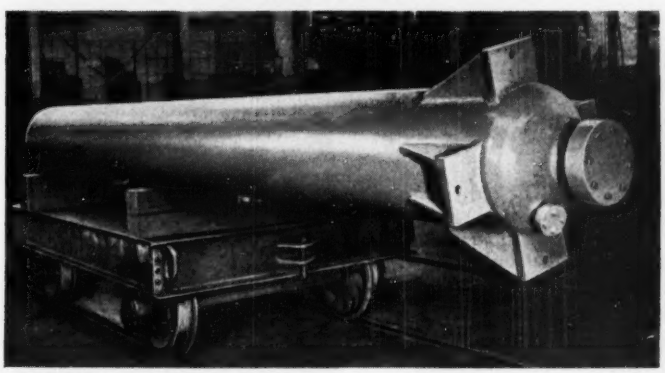
At B&W, forming, machining, welding, X-raying and stress relieving are all performed on equipment specially designed for the job, much of it developed by B&W. And for temperature and pressure problems that arise, new and practical solutions are continually being developed through designing skill based on long experience.



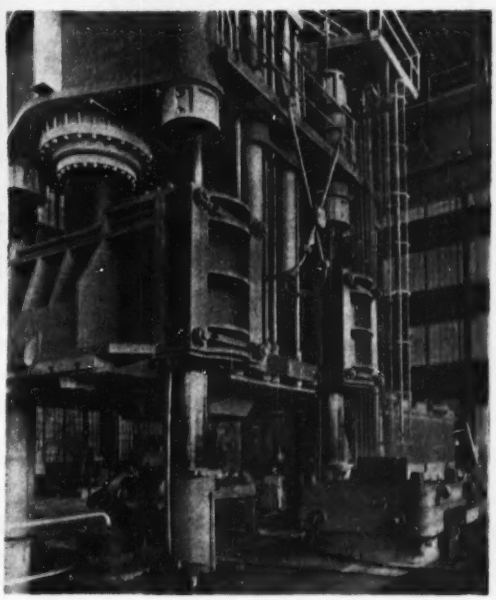
2,000,000-volt X-ray is the all-seeing eye that checks the soundness of welds.



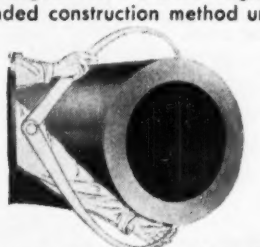
B&W Alloy Castings are cast-to-last . . . designed for long life under the most rigid service conditions requiring superior resistance to abrasion, corrosion, oxidation, high pressures and high temperatures.



B&W Accumulators are manufactured in the range from 500 to 6000 psi or higher, with capacities from 5 gallons to 10,000 gallons. Large accumulators designed to withstand higher pressures are fabricated by the banded construction method unique with B&W.



B&W's giant new press, used in making Hollow Forgings, and other products needed to meet industry's growing demands.

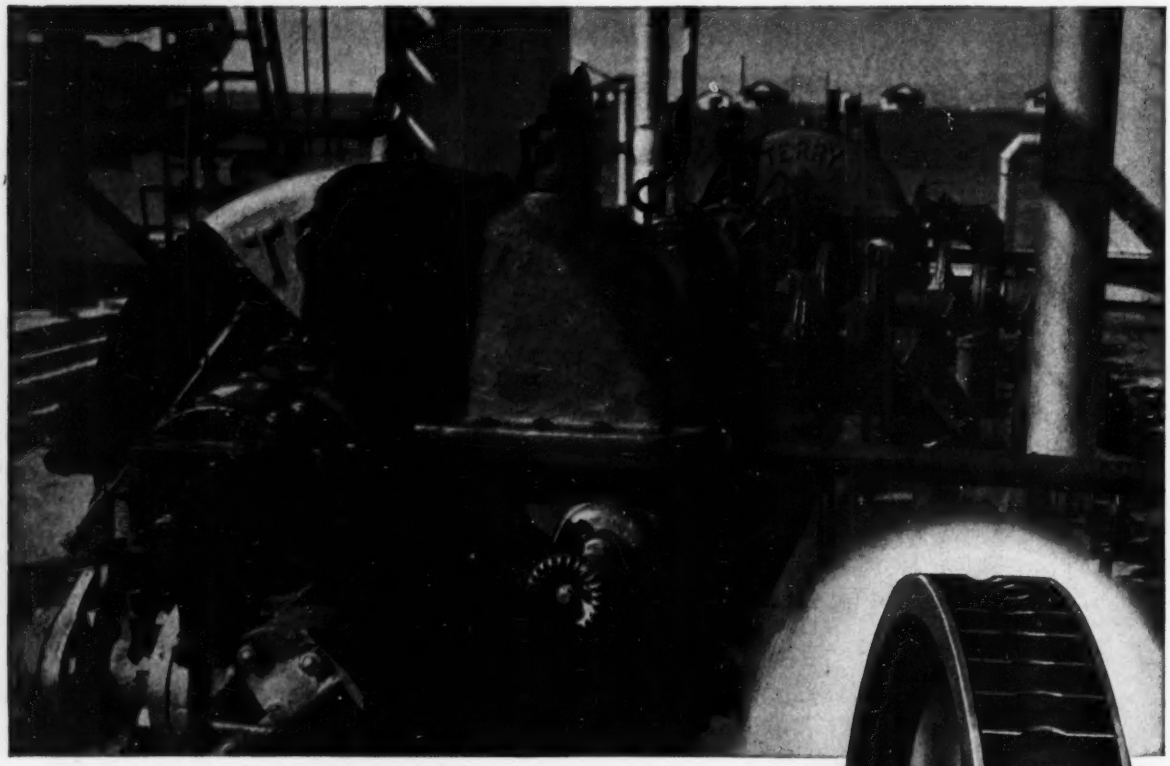


These large-diameter, heavy-wall pipes or tubes offer the designer the advantages of single lengths or many lengths, "tailor-made" to his requirements . . . prompt delivery even on small orders . . . full forging properties resulting from thorough working of the metal . . . excellent concentricity . . . wide size range available. Supplied in a wide range of carbon and alloy steels.

Write for detailed information about the B&W equipment you need to keep your plant in best condition to meet today's competition. The Babcock & Wilcox Company, Process Equipment Department, Barberton, Ohio.

BABCOCK & WILCOX

B-432



Two Terry Turbines equipped with "trouble eliminators"

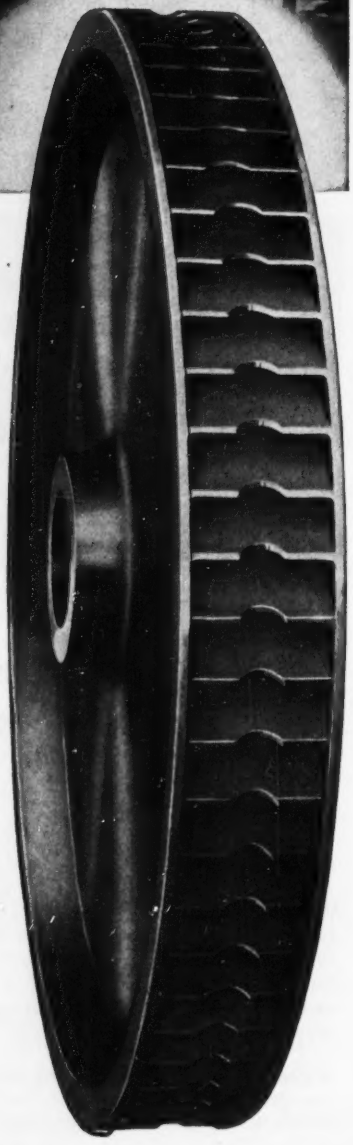
Because these turbines have solid wheels, they can take a lot of abuse, without complaint. Here's why:

1. The wheel has no separate parts to become loose or work out. It is a single forging, in which a series of semi-circular buckets is milled.

2. Blade wear is of little consequence because the power-producing action of the steam takes place on the curved surfaces at the back of the buckets. Wear does not materially affect horsepower or efficiency.

3. The blades cannot foul. There is a one inch clearance on either side of the wheel and, in addition, the blades are double rim protected. There is no need for close axial blade clearance, because the steam enters the buckets in a direction at right angles to the shaft.

For complete details of these *work horses of industry*, send for a copy of bulletin S-116. No cost or obligation.



THE TERRY STEAM TURBINE CO.

TERRY SQUARE, HARTFORD 1, CONN.

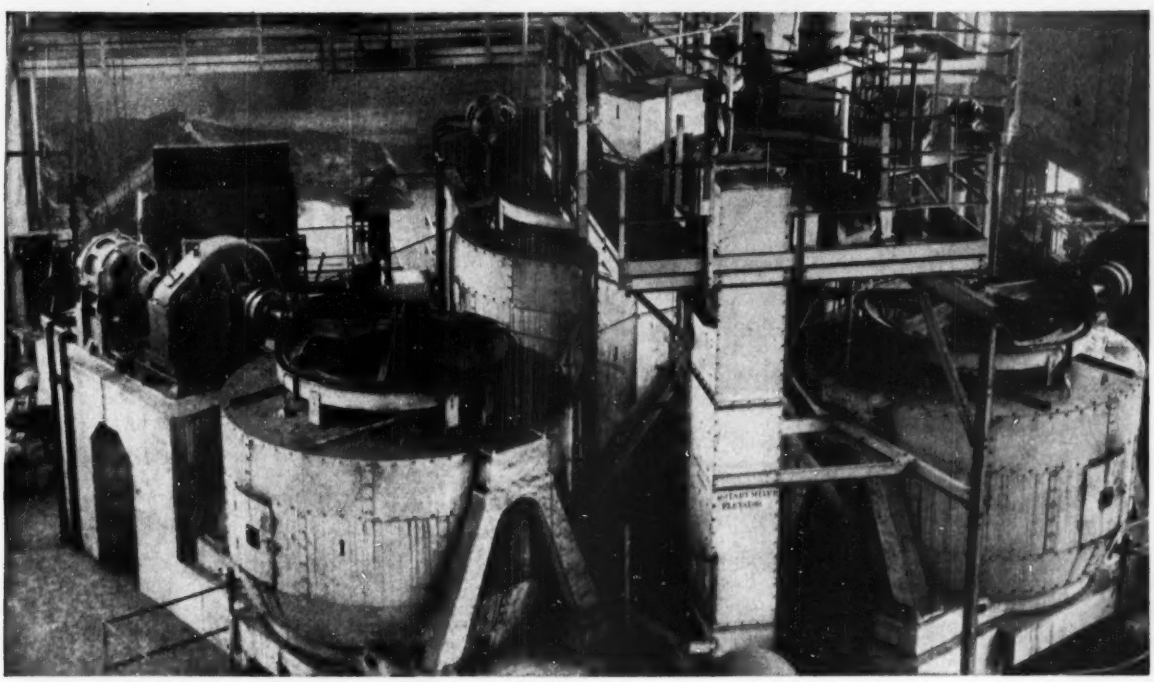
TERRY

TT-1199

TIME-TESTED CHASERS

built for The New Jersey Zinc Co. (of Pa.)

Result in Improved Performance



Illustrated above are three 12' diameter chasers installed in a plant operated by The New Jersey Zinc Co. (of Pa.). They are used for the preparation of a mixture which is later briquetted.

Any information on items listed below will be sent to you immediately:

- Rotary Kilns, Coolers and Dryers
- Rotary Retorts, Calciners, Etc.
- Improved Vertical Lime Kilns
- Automatic Quick-Lime Hydrators
- Briquetting Equipment
- Open-Hearth Steel Castings
- Heavy Duty Electric Hoists
- Self-Contained Electric Hoists
- Cast-Steel Sheaves & Gears
- Diesel Locomotives
- Electric Locomotives
- Steel Plate Fabrications
- Hydraulic Presses

From 1919 to the present time, The New Jersey Zinc Co. (of Pa.) has procured fourteen chasers (i.e. mullers, mixers, edgerunners, etc.), from The Vulcan Iron Works. These chasers are in continuous operation, and because of their specific operation they have been subjected to great wear and severe shock.

Over these years there has been the closest cooperation between the engineering and operating staffs of The New Jersey Zinc Co. (of Pa.) and The Vulcan Iron Works, resulting in continuous improvement in the Chasers.

Because of their arduous tasks, they are extremely sturdy in design, and improvements made in them over the years have resulted in a minimum of maintenance, considering their operation.

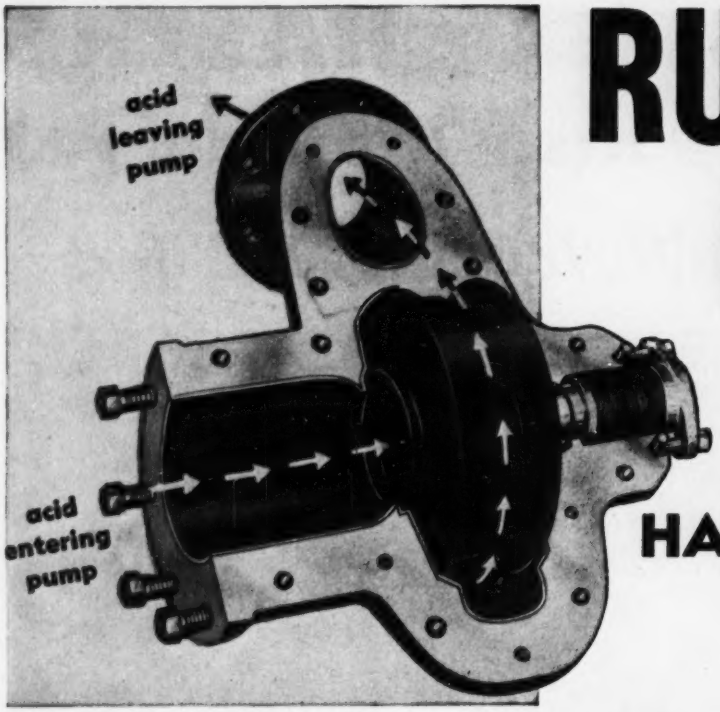
The Vulcan Iron Works and its 105 years of experience is ready and willing to work with your engineering department to combat any problems that may arise. Write for detailed Bulletins or information today.

VULCAN IRON WORKS

NEW YORK OFFICE
50 CHURCH ST., N.Y., N.Y.

WILKES-BARRE, PA., U.S.A.
ESTABLISHED 1849

CABLE ADDRESS
"VULWORKS WILKESBARRE"

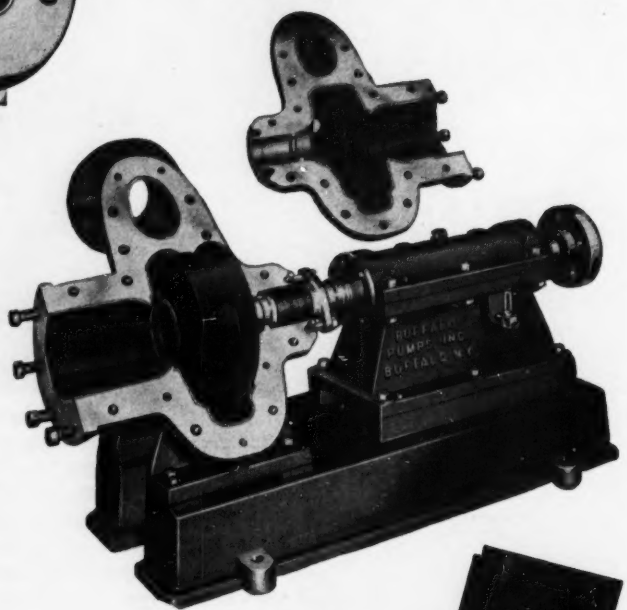


RUBBER LINING

CUTS ACID HANDLING COSTS

—IN THIS EFFICIENT, SERVICEABLE "BUFFALO" PUMP

Corrosive or abrasive-bearing solutions that would soon destroy ordinary pump impellers, shafts and casings are easily handled in this "Buffalo" Diagonally Split-Shell Chemical Pump! All parts in contact with liquid are bonded with the grade of rubber required for the liquid to be handled. Just one example of the wide line of Special "Buffalo" Pumps handling the vast group of liquids in the chemical industries at the lowest possible operating cost and the least possible maintenance. Whatever your conditions of corrosion, abrasion, temperature or hydraulic requirements, you'll find a "Buffalo" Pump tailor-made for that environment . . . one that will pay you in bonus years of dependable liquid moving!



Accessible for easy servicing! Showing how impeller, shaft and stuffing box are exposed by removing upper half of casing, without disturbing discharge piping.

WRITE TODAY for Engineering Bulletin 982 on our full line of Chemical Pumps.

"Buffalo" PUMPS

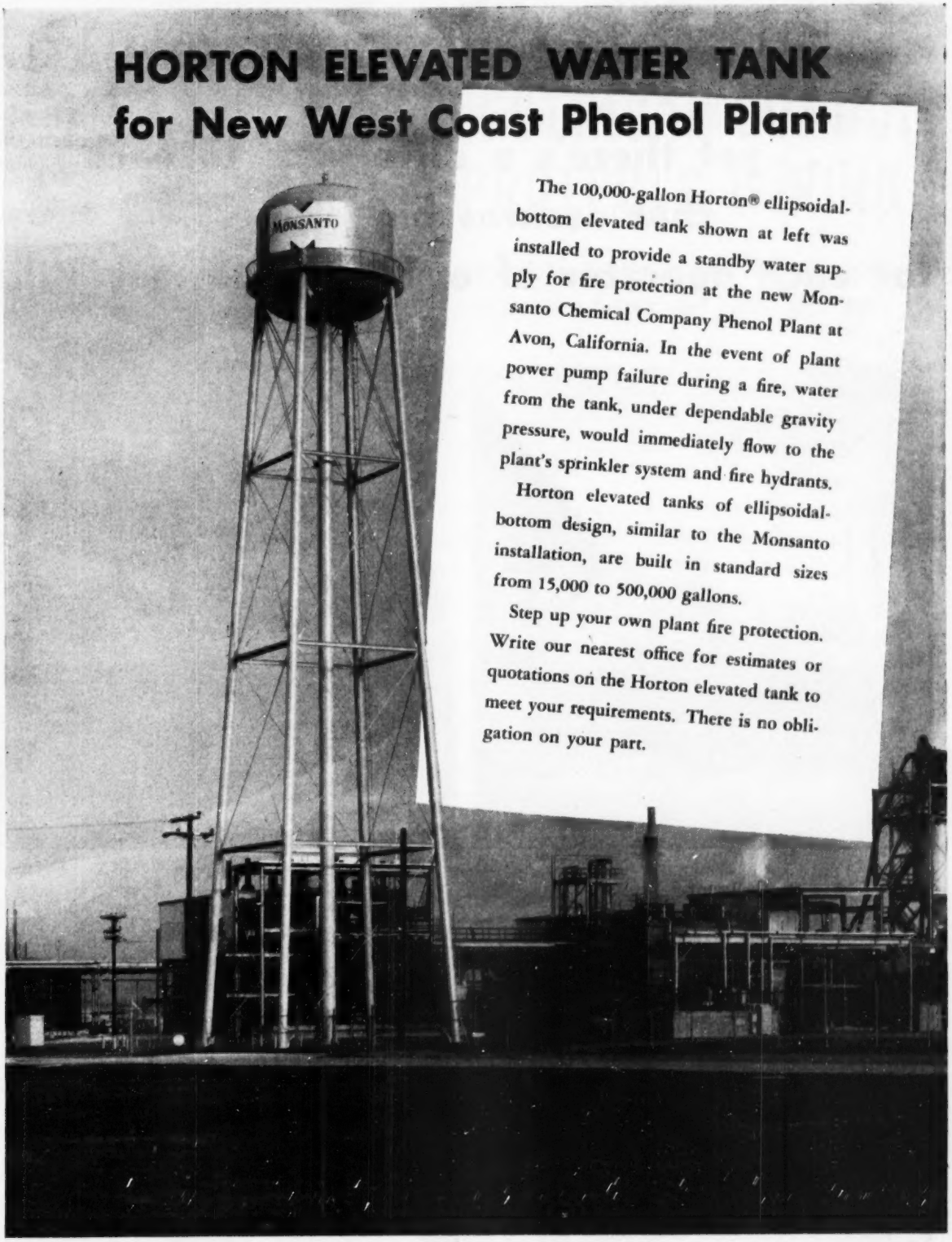
BUFFALO PUMPS, INC.

501 Broadway Buffalo, N. Y.

Subsidiary of Buffalo Forge Company, Canadian Pumps, Ltd., Kitchener, Ont.
Sales Representatives in all Principal Cities.

A BETTER CENTRIFUGAL PUMP FOR EVERY LIQUID

HORTON ELEVATED WATER TANK for New West Coast Phenol Plant



The 100,000-gallon Horton® ellipsoidal-bottom elevated tank shown at left was installed to provide a standby water supply for fire protection at the new Monsanto Chemical Company Phenol Plant at Avon, California. In the event of plant power pump failure during a fire, water from the tank, under dependable gravity pressure, would immediately flow to the plant's sprinkler system and fire hydrants.

Horton elevated tanks of ellipsoidal-bottom design, similar to the Monsanto installation, are built in standard sizes from 15,000 to 500,000 gallons.

Step up your own plant fire protection. Write our nearest office for estimates or quotations on the Horton elevated tank to meet your requirements. There is no obligation on your part.

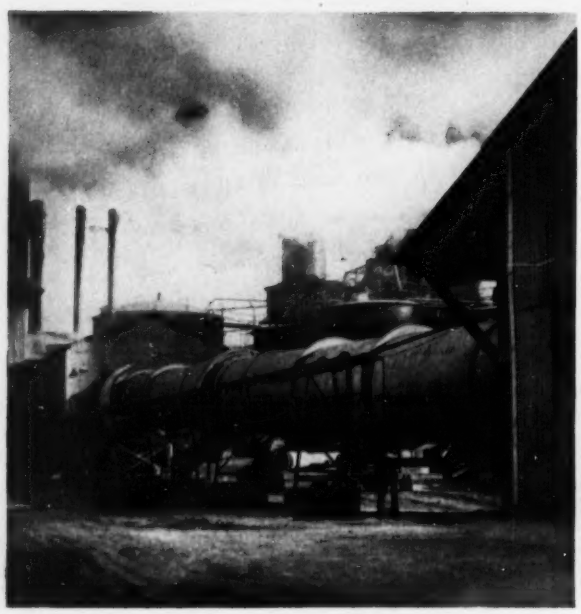
CHICAGO BRIDGE & IRON COMPANY

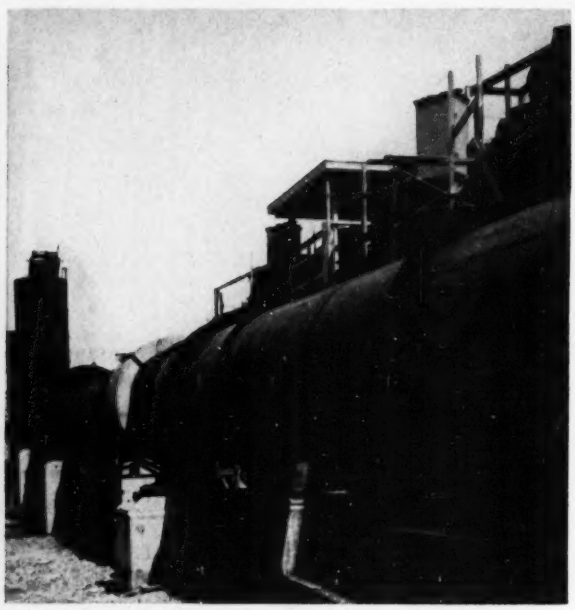
Atlanta 3.....2120 Healey Bldg.
Birmingham 1.....1510 North Fiftieth St.
Boston 10.....1005-201 Devonshire St.
Chicago 4.....2124 McCormick Bldg.
Cleveland 15.....2220 Midland Bldg.
Detroit 26.....1503 Lafayette Bldg.
Houston 2.....2103 C & I Life Bldg.
Los Angeles 17..1503 General Petroleum Bldg.
New York 6.....3318—165 Broadway Bldg.
Philadelphia 3...1625—1700 Walnut St. Bldg.
Pittsburgh 19.....3205 Alcoa Bldg.
Salt Lake City 4.....505 West 17th South St.
San Francisco 4.....1522—200 Bush St.
Seattle 1.....1305 Henry Bldg.
Tulsa 3.....1623 Hunt Bldg.

Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY and GREENVILLE, PENNSYLVANIA

basically alike

. . . yet there's a difference in each that assures big profits for each operator of a Traylor Rotary Kiln





TRAYLOR ENGINEERING & MFG. CO.
681 MILL ST., ALLENTOWN, PA.
SALES OFFICES: New York • Chicago • San Francisco
Canadian Mfrs: Canadian Vickers, Ltd., Montreal, P.Q.

It looks like a "Traylor-Made" Kiln will be best for me, too. I'd like more information, send bulletin 1115.

Name _____

Company _____

Address _____

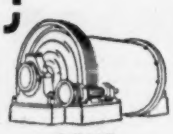
a *Traylor* leads to greater profits

In the new installation you are considering there's only *one* Rotary Kiln that's going to do the job with maximum efficiency and economy. The best thing to do is settle on a kiln "Traylor-Made" to your requirements. Adapting Traylor's basic design features to your individual needs will assure the success of your "Traylor-Made" Kiln before installation. The big difference in production and profits you get with a "Traylor-Made" Kiln is the direct result of Traylor's more than 40 years' experience in designing and building rotary kilns.

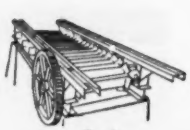
Primary Gyratory Crushers

Rotary Kilns

Secondary Gyratory Crushers


Ball Mills

Jaw Crushers


Apron Feeders

ELECTRICAL CONDUIT

PERMANENT
EASILY INSTALLED
LIQUID-TIGHT
FLEXIBLE
APPROVED

SEALTITE (TYPE U.A.) is approved by Underwriters' Laboratories, Inc. for use where exposed to moisture or mineral oils (up to 60C). See N.E. Code, Art. 351.

SEALTITE
ELECTRICAL CONDUIT PROTECTS WIRING

against oil, grease, water, dirt, chemicals, corrosive fumes, salt spray, weather

SEALTITE* is a flexible *and* liquid-tight electrical conduit. It gives maximum protection to your wiring when it must connect moving parts, absorb vibration, follow machine contours, flex into U-bends, be easily maintained or be safeguarded between misaligned ports.

It is being used successfully in wet locations, in tunnels, power plants, steel mills, canneries, chemical industries and in many outdoor applications. SEALTITE comes in two types:

TYPE U. A.—UL-approved. Made with flexible galvanized steel core, positive ground and tough outer cover.

NOM. I.D. (Inches)	INSIDE DIA. (Inches) Min.	Max.	OUTSIDE DIA. (Inches) Min.	Max.	APPROX. INSIDE BEND DIA. (Inches)	EST. WEIGHT per hundred ft. (Pounds)
⅜	.484	.504	.690	.710	8	30.0
½	.622	.642	.820	.840	10	36.6
¾	.820	.840	1.030	1.050	15	48.2
1	1.041	1.066	1.290	1.315	18	87.7
1¼	1.380	1.410	1.630	1.660	21	116.5

TYPE E. F.†(Extra Flexible)—for machine tools and industrial equipment. (Meets standards set by J.I.C.) †Pat. Applied For

NOM. I.D. (Inches)	INSIDE DIA. (Inches) Min.	Max.	OUTSIDE DIA. (Inches) Min.	Max.	APPROX. INSIDE BEND DIA. (Inches)	EST. WEIGHT per hundred ft. (Pounds)
⅜	.485	.505	.690	.710	5	24.3
½	.620	.640	.820	.840	6	29.0
¾	.815	.835	1.030	1.050	9	38.2
1	1.025	1.055	1.290	1.315	10	65.0
1¼	1.365	1.395	1.630	1.660	13	84.4
1½	1.575	1.605	1.870	1.900	15	122.0
2	2.020	2.055	2.335	2.375	17	158.0
2½	2.480	2.515	2.840	2.875	20	205.0
3	3.070	3.110	3.460	3.500	27	290.0
4	4.000	4.050	4.460	4.500	34	430.0

Commercial tolerances apply on above figures.

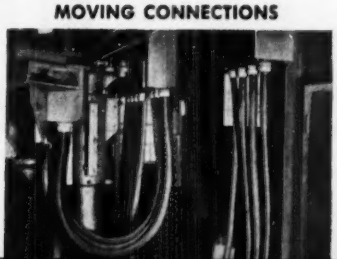
ELECTRICAL WHOLESALERS stock both types. Buy it in long random lengths as shown; then cut without waste. Or ask your wholesaler to cut the length you need. Liquid-tight connectors are available from wholesalers' stocks. Write for Bulletin UA-531. *The American Brass Company, American Metal Hose Branch, Waterbury 20, Conn.*

*Trade Mark 84175

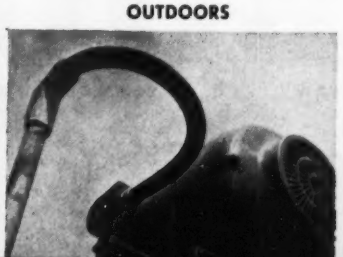
SEALTITE flexible, liquid-tight electrical conduit an **ANACONDA®** product

FOR WET SPOTS

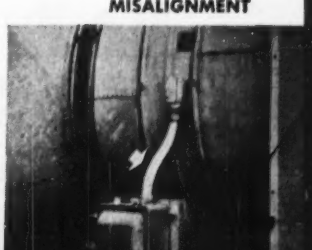
MOVING CONNECTIONS

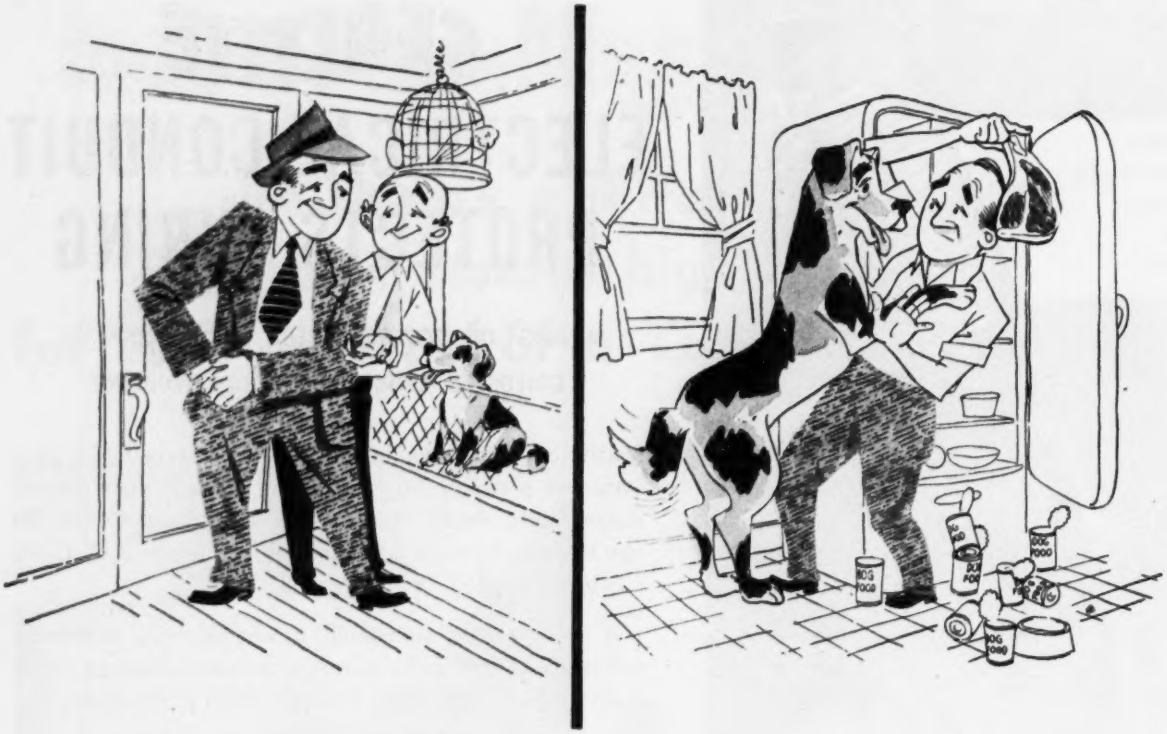


OUTDOORS



MISALIGNMENT





It was a low priced pup...

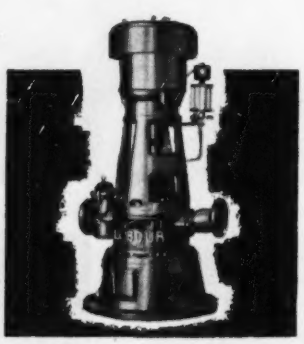
He didn't know much about dogs, or he would have understood why the dealer was willing to offer such a bargain.

can you tie this?

A well-known rubber company purchased 31 LaBour Type G pumps in eight years. Up to June, 1954, this company had purchased $1096.79 worth of repair parts from LaBour. Assuming that none of these parts is being held in reserve, the average cost per pump per year for repair parts is $10.52.

Sometimes a mistake isn't so obvious. Take corrosive-service pumps for instance. Do you *know* what you pay for replacement parts the first year, or the second? Maybe you ought to look into this matter—you may be as surprised as our friend pictured above.

If you bought LaBour Type G pumps a year or two ago—or five—your surprise will be a pleasant one. But whatever pumps you *did* buy, we urge you to dig out the facts about what they cost for maintenance in labor and materials, and make your own comparisons.



ORIGINAL MANUFACTURERS OF THE SELF-PRIMING CENTRIFUGAL PUMP

LABOUR

THE LABOUR COMPANY, INC. • ELKHART, INDIANA, U.S.A.

WHY IT PAYS TO BUY SPECIALTIES FROM US

You get quality products, fast delivery—*anywhere*

TRIPLE SECURITY

What you want
When you want it
At the right price

• Maybe you didn't know it, but U. S. Steel Supply can supply you with everything you need in the way of industrial supplies, as well as with the *steel* you need.

Call us for—Dardelet Rivet Bolts, High Strength Bolts, Blakled (a new rust-inhibiting material), Grinding Wheels, expanded metal, chain and chain slings, welding electrodes, welding machines, clamps, Markal Paintstiks, Galv-Weld (for regalvanizing welded areas), mechanical rubber goods—conveyor belts, transmission belts, all types of hose, V-Belts, structural fabricating machinery, sheet metal machinery.

These items are carried in stock ready for immediate delivery. For complete information and literature, fill out the coupon below and send to us.

U. S. STEEL SUPPLY
DIVISION

General Offices
208 So. La Salle St., Chicago 4, Ill.

USS

Warehouses and Sales Offices
Coast to Coast

U. S. Steel Supply Division
208 So. La Salle St., Chicago 4, Illinois
Gentlemen:
Please send me your free literature describing the following items:

....
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Company.....
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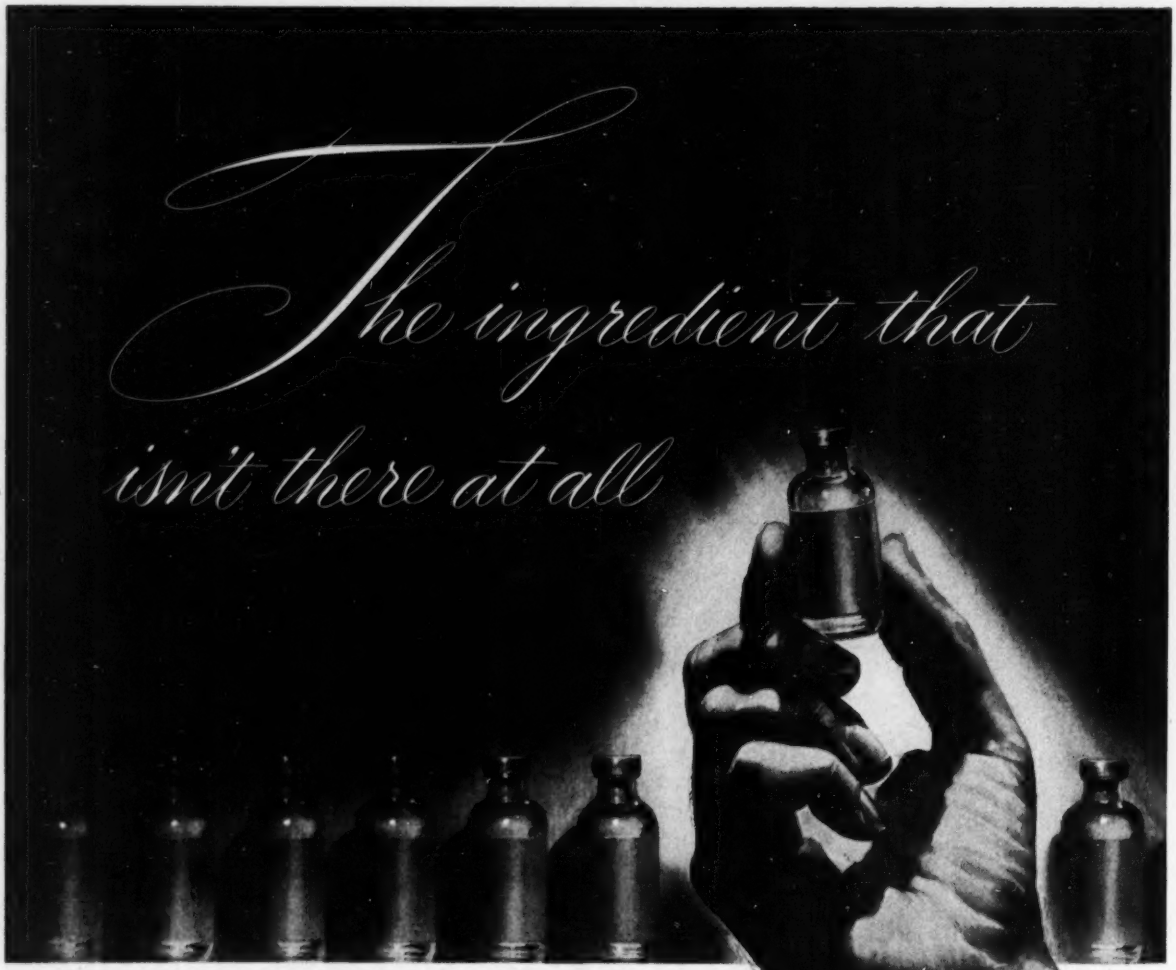
City.....State.....

UNITED STATES STEEL



CAN MAKE POSSIBLE
THE GIFT OF LIFE ITSELF

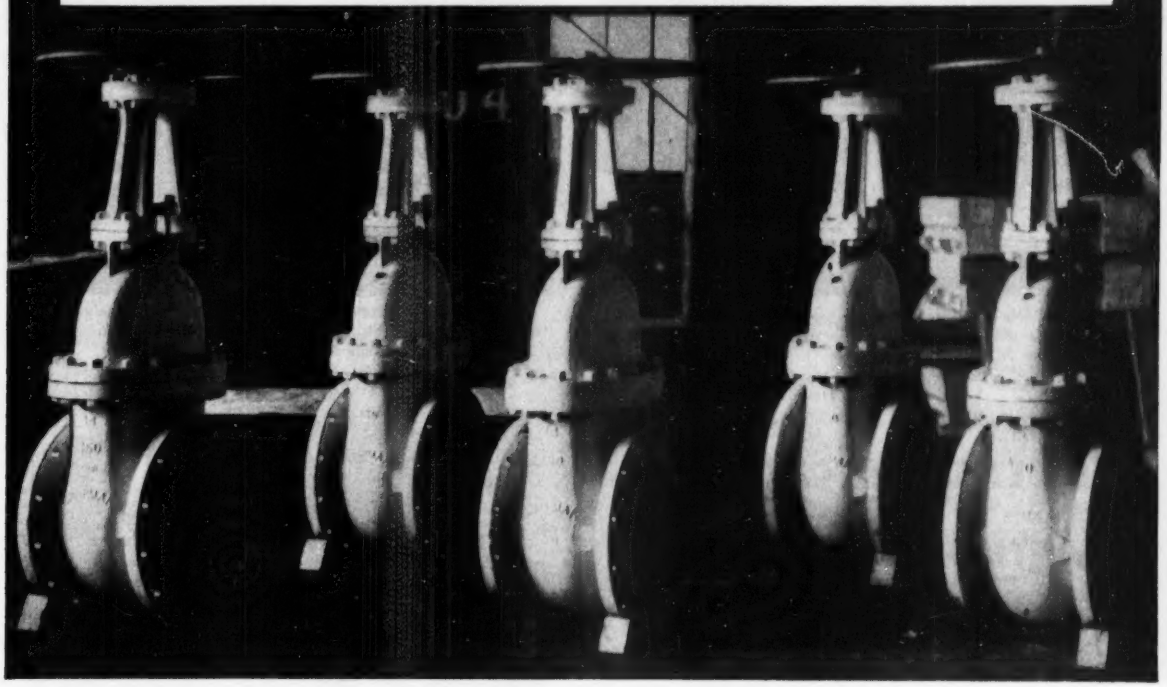
In all the glamour stories on the "miracle drugs"... penicillin, streptomycin, aureomycin, terramycin, to name the most familiar ones... there is no single word about *diatomite* – nor can you find the slightest trace of diatomite in the life-saving drugs themselves. Yet the ingredient that isn't there at all, diatomite, plays a vital role in antibiotic production, for, as a filteraid, it gives filtration "sharp" enough to remove all unwanted solids, even those in the submicron range.

Dicalite is the trade name of diatomaceous materials produced by the Dicalite Division of Great Lakes Carbon Corporation. We are proud of the part it has played, and is playing, in producing a number of these "wonder drugs." Because of its purity, its uniformity and its chemical inertness, Dicalite is helping to push forward the frontiers of scientific progress in this and in many other fields. Its uses, even today, are too numerous to list here, and new applications are discovered almost every week.

Dependable
GLC GREAT LAKES **Dicalite**
DIATOMACEOUS MATERIALS

For complete information on Dicalite—diatomaceous filteraids, for example—please write for Bulletin B-12. Dicalite Division, Great Lakes Carbon Corp., 612 S. Flower St., Los Angeles 17, Calif.

Approximately 500 Gate Valves similar to these cast in 2.50/3.00% nickel steel for -150°F. service were recently shipped to a large chemical company by Chapman Valve Mfg. Co., Indian Orchard, Mass. Ranging from 2" to 20" sizes in the 150, 300, 600 and 900 lb. series, and made to ASA B16 5-1953 specifications, this order required the melting of 500,000 lbs. of steel.



Why these valves stay strong at -150° F

Carbon steels and many alloy steels become brittle at low temperatures.

The addition of nickel, however, increases resistance of steel to sub-zero embrittlement. That's why Chapman Valve Manufacturing Company regularly uses nickel steel for valves intended for low temperature service.

Chapman produced the group of valves, shown above, in low carbon 2.50/3.00% nickel steel, to assure adequate toughness under operating temperatures of -150°F.

Tests of seven heats of this steel provided the following average mechanical properties, after double normalizing and tempering:

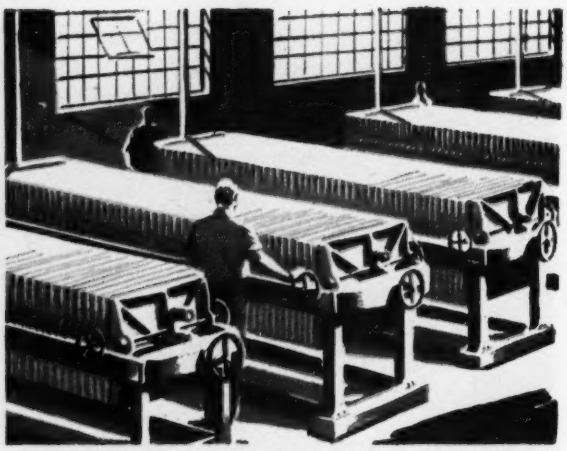
Tensile Strength, p.s.i.	80,900
Yield Strength, p.s.i.	48,600
Brinell Hardness	153
Elongation in 2" %	30.3
Reduction of Area %	52.7
Charpy Impact, (Keyhole) ft. lbs. at -150°F.	32.9

This exemplifies the way ample toughness for sub-zero service . . . as well as strength and toughness at normal temperatures . . . can be assured by using suitable nickel steels.

Whatever the temperatures of your operations, consult us on the use of nickel alloy steels, nickel alloy irons or other alloys containing nickel in your equipment. Send us details of your problems for our suggestions . . . write today.

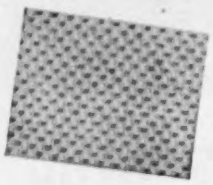
THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK 5, N. Y.

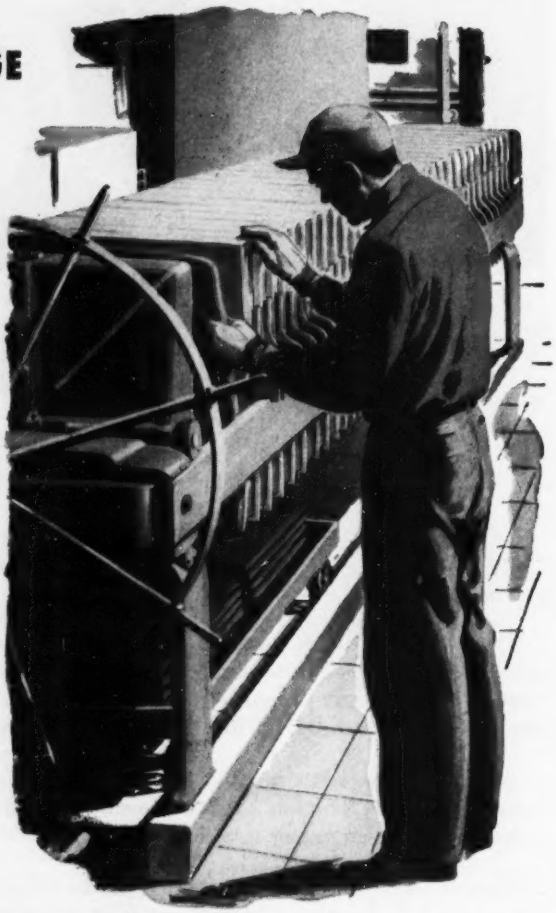
Cotton filter fabrics—widely used in beet sugar processing—are economical, durable, have high wet strength and good mechanical efficiency.



Acrylic type fibers when made up into filter fabrics are highly resistant to strong mineral acids under elevated temperature conditions such as used in certain dye filtration processes.

YOU GET EASIER CAKE DISCHARGE WITH THIS WELLINGTON SEARS FILTER FABRIC





Shown here in use is a press equipped with Wellington Sears filter fabric in a special construction of filament nylon, designed expressly for clay filtration. It is made to stand up under abrasion and flexing . . . and smooth enough for easy cake discharge.

Whatever your "tough problem" there's most likely a Wellington Sears fabric already in use—or one that we can develop—to solve it. There's the confidence in over a century of industrial fabric experience to back up that statement.

Wellington Sears cotton and synthetic filter fabrics are made available to the processing industries through leading filter cloth specialists. Write us for names of those serving your area.

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A SUBSIDIARY OF WEST POINT MANUFACTURING COMPANY

FIRST In Fabrics For Industry

WELLINGTON SEARS COMPANY, 65 WORTH STREET, NEW YORK 13, N. Y.

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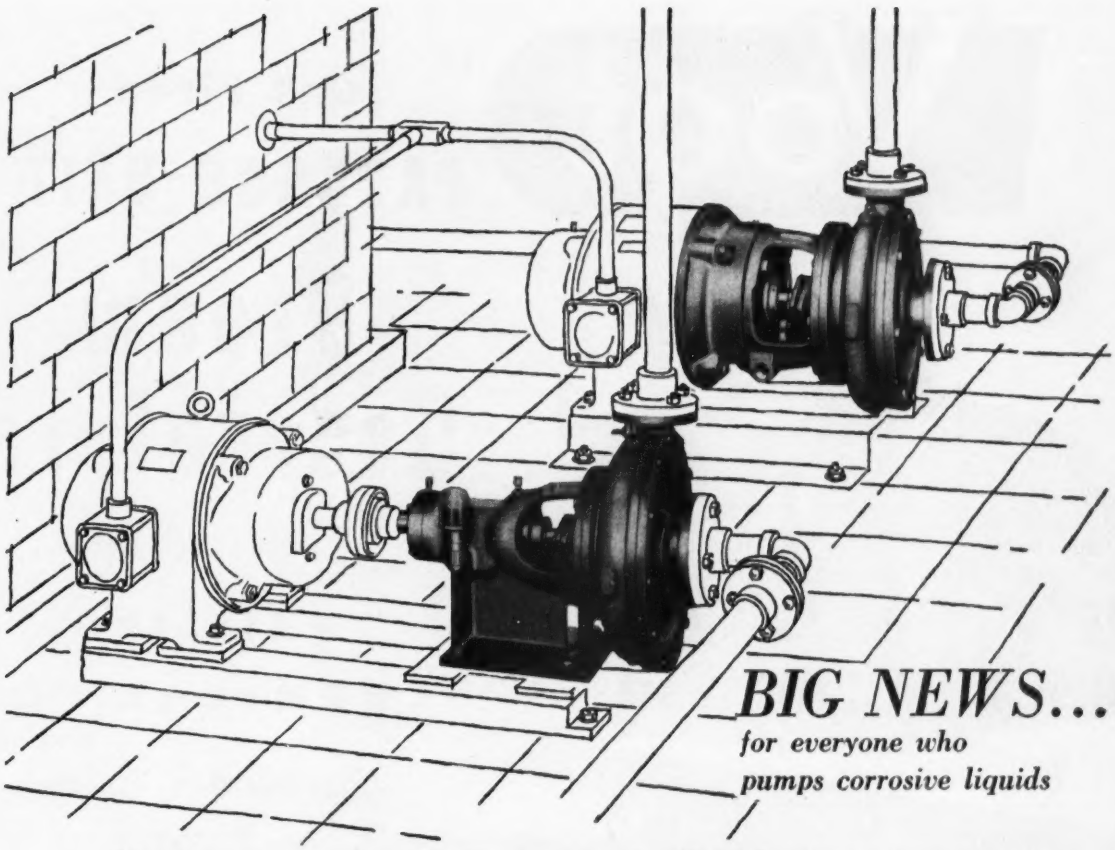

BIG NEWS...

for everyone who pumps corrosive liquids

Now you can get the **"custom-built"** *features you want at no penalty with the new* **AMPCO*** **Centrifugal Pump**

In a given pump size, new standard units give at least 108 different combinations, plus maximum resistance to corrosion, erosion, cavitation

Here's low-cost corrosive liquid transfer at its new, versatile best. If you require pumps in flows up to 600 gpm, this new 1750 rpm pump is exactly right for you. It can be built to *your* special requirements by interchanging standard parts.

You can select the bearings you want — sealed, replenishable-grease, or oil-lubricated.

You can choose your shaft seals — inside or outside mechanical seals; internal, external, or flushing packed stuffing-boxes.

You can get the exact shaft you need — no compromising. Take your choice of general-purpose and extra-rigid shafts as well as a new two-piece unit that allows removal of the rotating parts without disturbing coupling, bearings, or alignment.

You can select the pedestal height and type impeller you want.

Best of all, you don't have to buy another pump when conditions change. You can make modifications quickly and inexpensively in the field — save yourself valuable time and money.

Corrosion damage? Forget it. These pumps are built entirely from Ampco or other workable alloys to combat the effects of corrosive acids, alkalis, organic chemicals, etc. And these pumps have many new design features — features that contribute to dependable, maintenance-free pumping.

The new Ampco 1750 rpm Pumps are now stocked for immediate delivery. Contact your Ampco Pump Distributor or Field Engineer or mail the coupon.

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West Coast Plant • Burbank, California

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The new Ampco Pump sounds good to me. Send me additional information. I pump.....

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Company.....

Company Address.....

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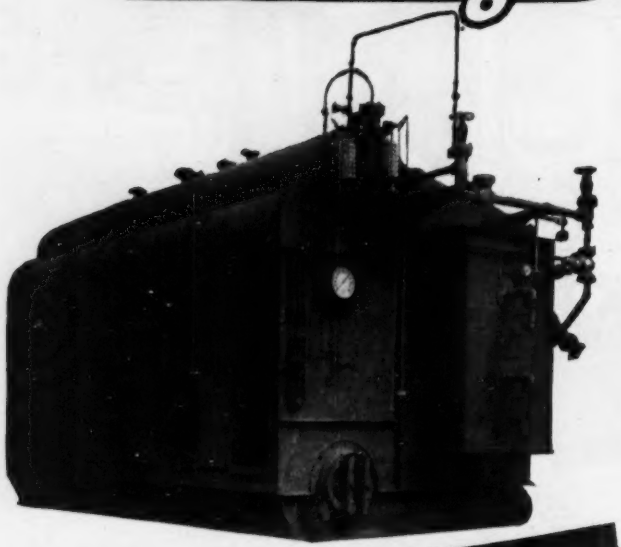
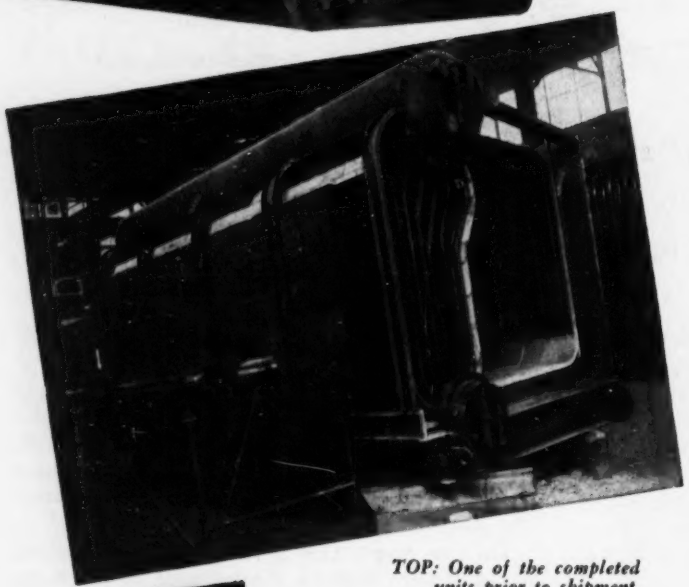
Maximum Interchangeability without Penalty

P-13

Vogt

Gas Fired
PACKAGE UNIT
Steam Generators
selected by
PHILLIPS CHEMICAL CO.
Pasadena, Texas Plant





TOP: One of the completed units prior to shipment.

BOTTOM: Shop erection view shows tile and block insulation in convection wall; also main baffle tile and furnace floor tile.

Principal Data, Each Unit

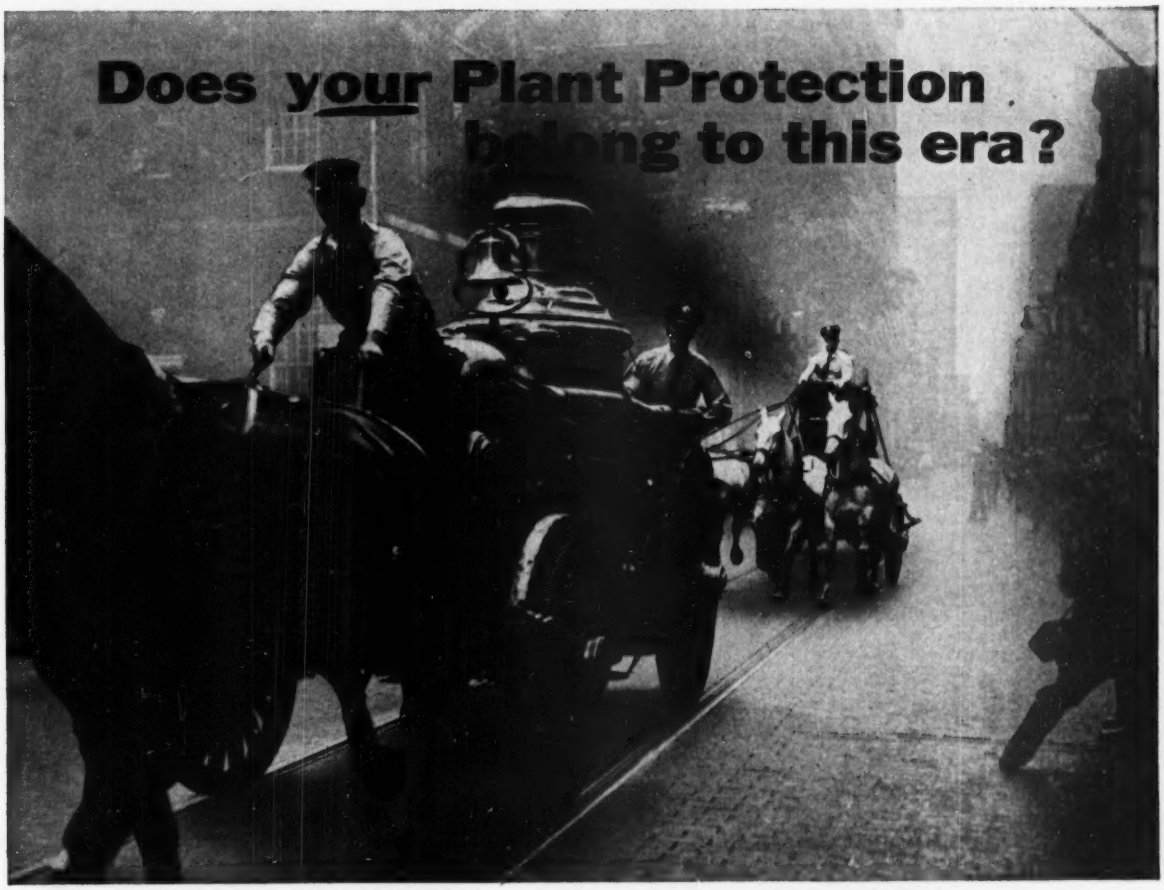
25,000 pounds steam per hour capacity. Induced draft type.
Fusion welded steam and water drums designed for 425 pound S.W.P.
Completely shop assembled and required only the piping and gas outlet connections to place them in operation.
Fully steel encased for outdoor installation on a simple foundation.

•

**Vogt Steam Generators are available in bent tube types and straight tube forged sectional header types for solid, liquid or gaseous fuels. Bulletins on request.*

HENRY VOGT MACHINE CO.
Louisville, Kentucky

BRANCH OFFICES: New York, Philadelphia, Chicago, Cleveland, St. Louis, Dallas, Charleston, W. Va.



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The science of fire-engineering has come a long way since the era of the horse-drawn fire engine. Now you can protect your flammable liquid fire hazards by calling in National Foam engineers, who survey your plant and plan a modern fire-engineered system for your particular needs. They check locations, processes, flash points, existing system, water supply, and other factors. They recommend a basic AER-O-FOAM System with manual or automatic control, stationary or mobile operation, and all the proper equipment . . . foam chambers, overhead units, dip-tank systems, nozzles, extinguishers. After installation, National Foam furnishes a complete operating manual.

National Foam's modern fire-engineered service offers the best in system design, equipment, and instant, positive, fire-tested AER-O-FOAM. Call in National today to discuss your flammable liquid fire problem.

Write for new, free booklet, "Foam Fire Protection"

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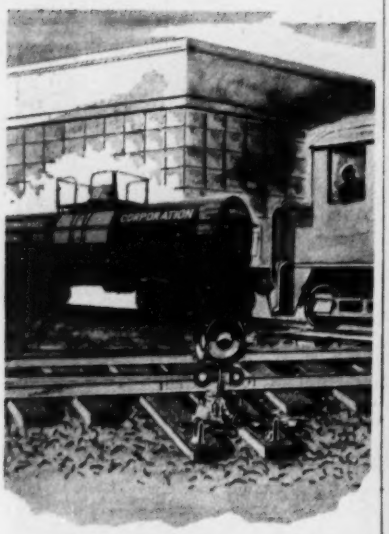
Headquarters for Foam Fire Protection — WEST CHESTER, PA.



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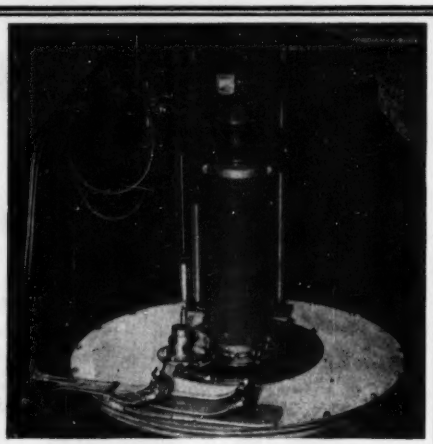

The latest Fletcher development in its line of modern high-speed centrifugals is the use of pneumatic controls to greatly ease and simplify unloading operation. By this means the back-breaking and fatiguing hand cranking operation is eliminated, and the operator's efficiency is materially increased. The scraper is at all times under complete control.

The air-operated unloader also simplifies the design of a fume hood for noxious gases.

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3. Product of high purity
4. Exceptionally uniform crystals
5. Controllable crystal size

Ammonium sulfate crystals from technical grade acid

Potassium chloride crystals

Ammonium sulfate from by-product acid

Shop view of Krystal Crystallization Equipment. This unit is 50' 0'' high and 11'3'' in base diameter.

Shown above is a typical installation of a Struthers Wells Krystal vacuum crystallizer.

Krystal crystalliization equipment provides efficient separation of crystals and mother liquor—reduces amount of wash water—eliminates dust losses—reduces caking of material in storage and produces free flowing crystals of superior appearance.

Struthers Wells

STRUTHERS WELLS CORPORATION WARREN, PA.

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THE C. O. JELLIFF MFG. CORP.
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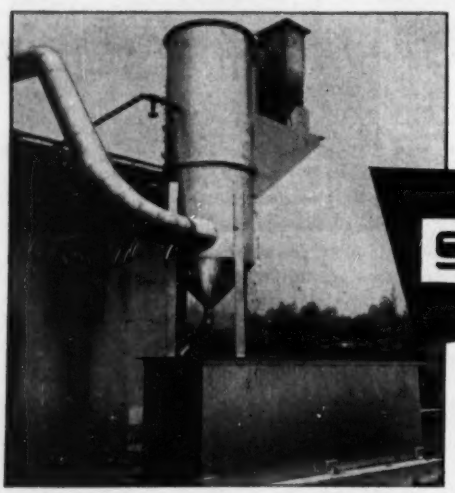
WIRE PRODUCTS Jelliff SINCE - 1880

EXPLOSIVE DUSTS

FUMES AND VAPORS
MADE SAFE WITH
MULTI-WASH
COLLECTORS



The explosion hazard is ever present in many chemical process plants. Control of this hazard has been achieved by many big-name processors with the Multi-Wash system of collection.

The versatility of the Multi-Wash Collector, its simplicity and efficiency, make it the most economical buy in its field.

Not only will Multi-Wash solve your dust, fume or vapor problem, but return the investment in recovery of valuable by-products.

Be sure to get all the answers before you allocate any money for dust control equipment.

Your nearest Schneible engineer is at your service, or if you like, call the home office, collect.

SCHNEIBLE

Write for Bulletins Nos. 531 and 610—No obligation of course.

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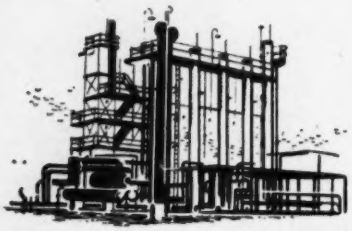
PROBLEM

To produce hydrogen essentially free of carbon monoxide which has a deleterious effect on product quality and plant capacity for edible oil producers.



SOLUTION

GIRDLER developed a highly active durable catalyst, G-12, for removal of carbon monoxide from the hydrogen. Cost of hydrogen production was reduced and carbon monoxide content was cut 95% resulting in:

Hydrogen with less than 5ppm of carbon monoxide

Take advantage of the experience of Girdler in solving *your* catalyst problems!

FOR
Catalysts

WRITE...
The
GIRDLER
Company

A DIVISION OF
NATIONAL CYLINDER GAS COMPANY
Gas Processes Division
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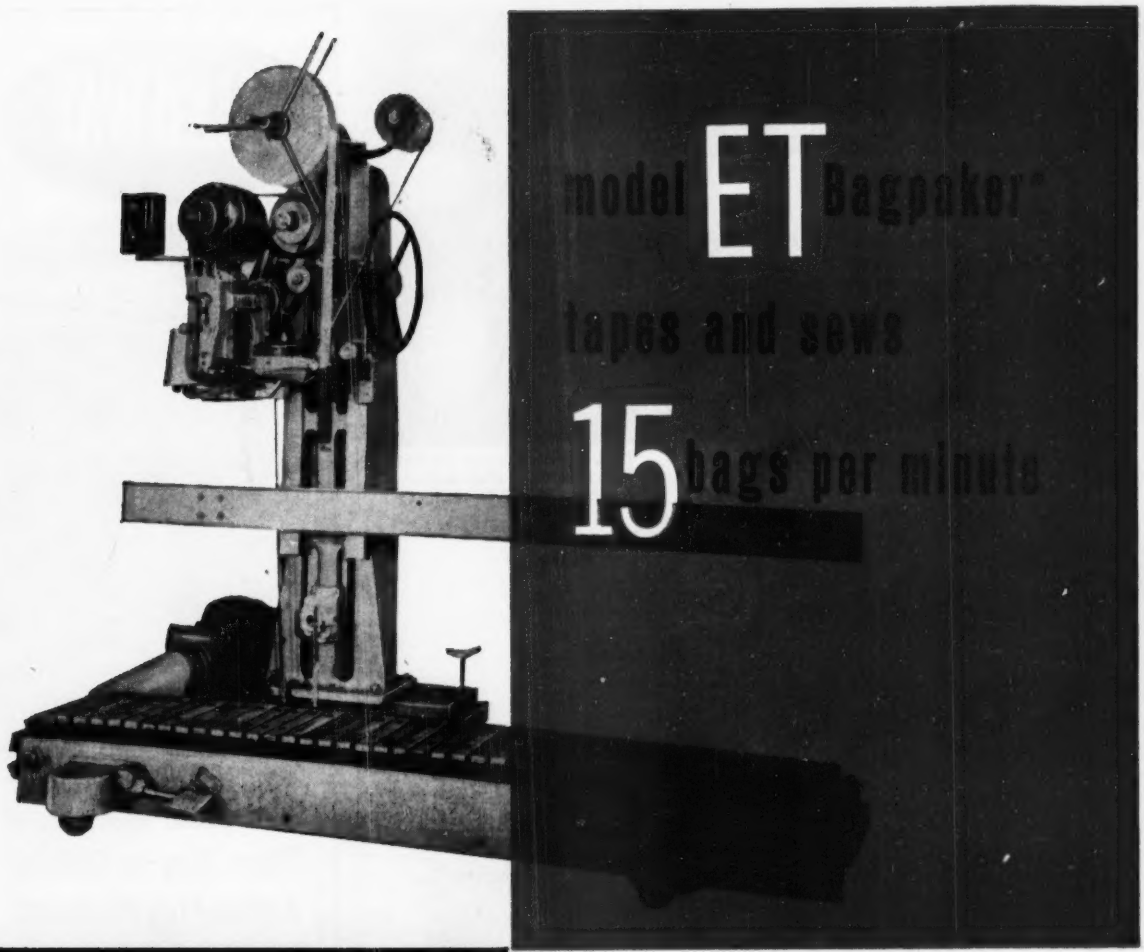
NEW YORK • TULSA • SAN FRANCISCO



TAKE ADVANTAGE OF THESE 5 MODEL ET BAGPAKER FEATURES:

- One operator finishes 15 bags a minute when filled bags are delivered continuously to the conveyor
- Adjusts to bags from 25 to 100 lb. capacity
- Caster-mounted, the Model ET is easily moved to widely separated packaging stations
- Bag starts and stops sewing head when equipped with automatic sewing head control
- Automatic brake on Howpner No. 150 Heavy Duty sewing unit prevents "coasting"

Here's the perfect teammate for your present filling and weighing equipment—the most efficient way to get better protection and faster packaging at the lowest possible cost.

Here's how the Model ET Bagpaker works: One operator receives bags from your weighing and filling machine. In four seconds or less the Bagpaker has applied creped "kraft" sealing tape over the bag end, sewn a reinforced "cushion stitch" through both tape and bag, and trimmed the tape. You can't beat that for efficiency and speed.

Booklet ET gives you complete details and dimensional drawings, shows you how perfectly Model ET fits into your existing filling set-up. There's no obligation—just write to: E-16

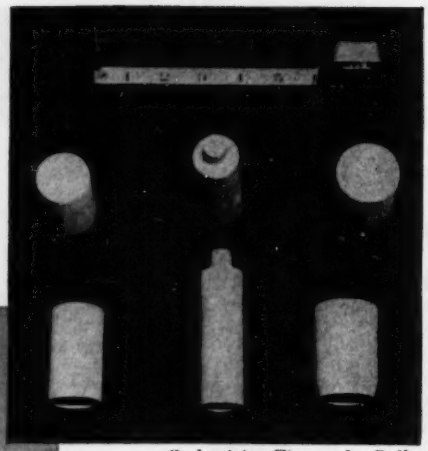
International Paper Company, Bagpak Division
220 E. 42 Street, New York 17

International Paper COMPANY
BAGPAK DIVISION

BRANCH OFFICES: Atlanta · Baltimore · Baxter Springs, Kansas · Boston · Chicago · Cincinnati · Cleveland · Dallas · Denver · Des Moines · Detroit · Kansas City, Kansas · Los Angeles · Louisville · Minneapolis · New Orleans · Philadelphia · Pittsburgh · St. Louis · San Francisco · IN CANADA: The Continental Paper Products, Ltd., Montreal, Ottawa, Toronto

Small

HIGH ALLOY
CASTINGS

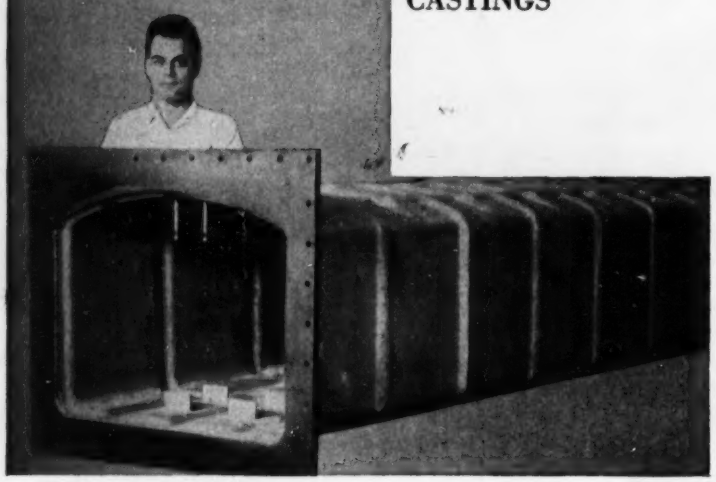


Carburizing Fixture for Ball Bearings 1½" diameter—
Analysis 35% Ni — 15% Cr

DURALOY

Large

HIGH ALLOY
CASTINGS



Muffle for Continuous Strip Annealing
12' 6" long — Analysis 38% Ni — 18% Cr.

LARGE or small DURALOY, can do it! These are just typical examples of the work moving through our foundry. Some of these castings are designed for heat resistance, some for corrosion resistance, some for abrasion resistance; all are cast by experienced foundrymen. All are carefully tested in our up-to-date laboratory.

If you have a high alloy casting problem . . . LARGE or small, we can help you. For more information, send for Bulletin No. 3150-G.

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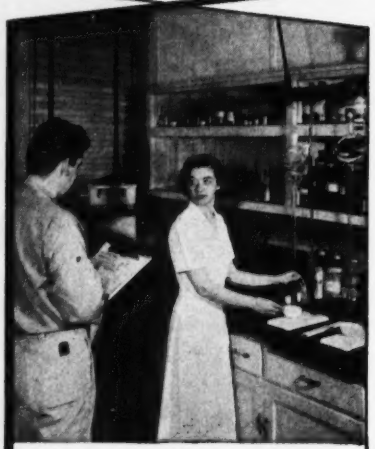
ILLCO-WAY

ionXchange



Pilot-Plant Tests Show New Way to Obtain Amine-Free Methanol

ILLCO-WAY ionXchange equipment has proved extremely successful in removing excess amounts of ammonia and organic amines which are produced at certain times in the synthesis of methanol from carbon dioxide and hydrogen. The contamination occurs during the shut-down and starting periods of the converter, events which are unpredictable in normal plant operation. When the pilot plant was built, following laboratory exploration of the theoretical possibilities, it was found that even greater economies can be obtained by the use of ionXchange methods. These included full retention on the exchange resin of heavy metals such as iron and copper, and elimination of several intermediate processes normally required to produce an acceptable product. The result now is an end-product substantially lower in contaminants, much more uniform, and noticeably more economical to manufacture, in comparison with ordinary methods. *Let one of our experienced technicians consult with you whenever there is a chance that ionXchange principles may be applicable.*

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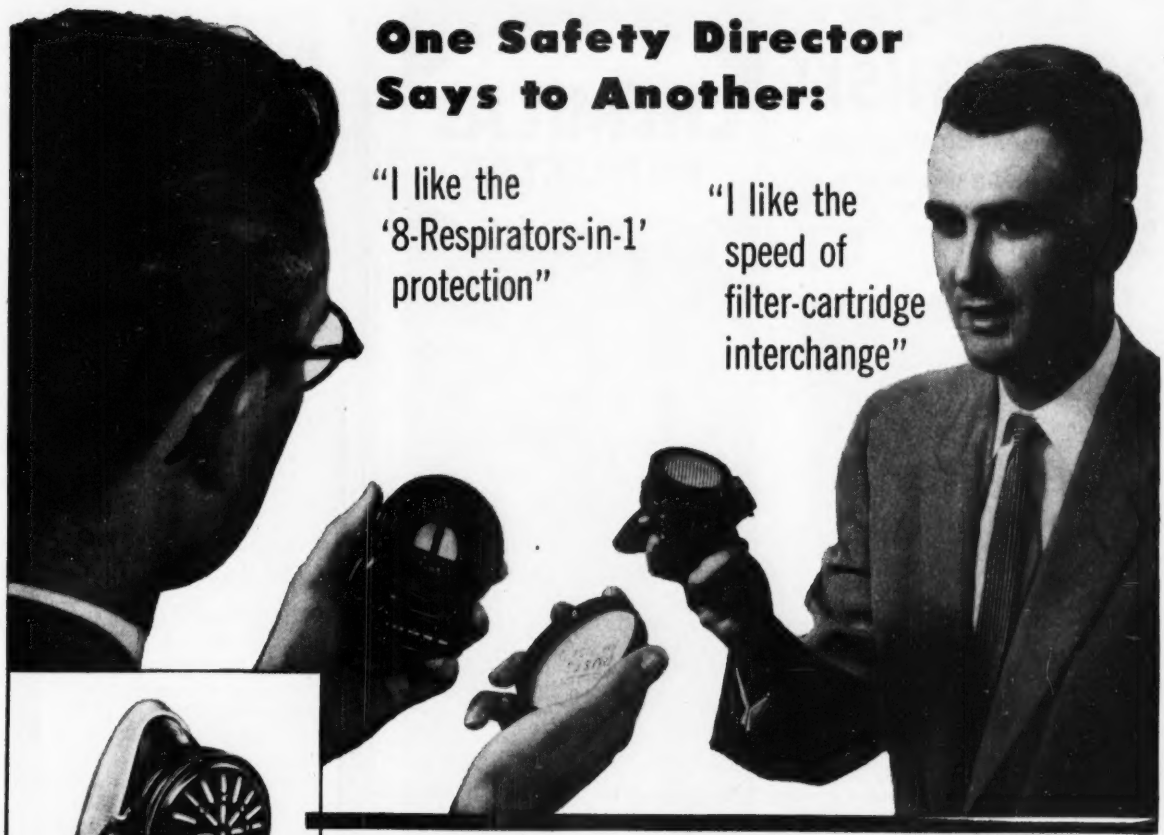
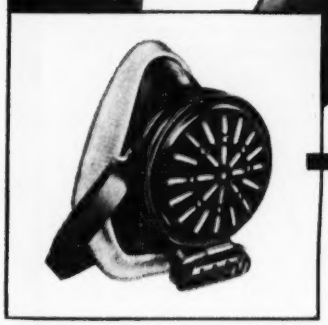
"I like the '8-Respirators-in-1' protection"

"I like the speed of filter-cartridge interchange"





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Want a single, interchangeable cartridge respirator that will protect your workers against (1) nuisance and pneumoconiosis-producing dusts (2) toxic dusts (not significantly more toxic than lead) (3) combination of all dusts (4) light organic gases and vapors (5) acid gases and vapors (6) combined acid and organic gases (7) ammonia (8) poisonous, disease-producing and a combination of dusts (not significantly more toxic than lead)? You get it with the AO R2000 and its 7 interchangeable cartridges, chemically treated felt filter (an AO "first") and prefilter for painting exposures.

Speed of interchange? *It couldn't be faster!* A twist removes the metal filter cover. Take out the R31 organic vapor cartridge for instance, and insert an R32, (the acid gas cartridge) or an R33 (acid-organic) or R34 (ammonia). Do the same for dust protection, using the recommended AO dust cartridge.

Quick Facts

And remember these advantages of AO research and engineering . . . the Flexible Neoprene Rubber Facepiece gives a leak-proof fit . . . Cartridges R31, R32, R33, R34 are made of durable, non-sparking materials . . . weigh less than previous types . . . the double headband is convenient and comfortable. Yes, and the entire respirator can be disassembled quickly without tools. Your nearest AO Safety Products Representative can supply you with the right equipment.

American Optical
SAFETY PRODUCTS DIVISION

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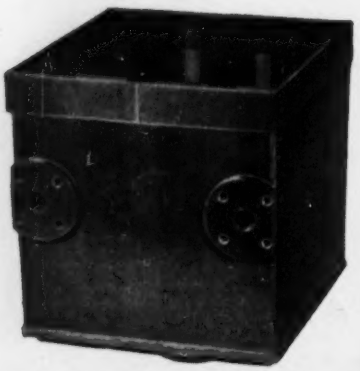
says EASTMAN KODAK

. . . but bleach cells made of Boltaron 6200 remained completely unaffected by corrosion after 3 years of continuous use



Bleach cell made of Boltaron 6200 to specifications of Eastman Kodak Company, Rochester, N. Y., by Industrial Plastic Fabricators, Norwood, Mass.

"We purchased Boltaron," reports Eastman Kodak Company, "in an effort to find a superior material from which to construct bleach cells." That was in 1951. Today with 50 of these bleach cells in operation, Eastman Kodak has this to say of Boltaron 6200: "This material has solved our maintenance and replacement problem."

Boltaron 6200 is a rigid, unplasticized Polyvinyl Chloride, highly adaptable to complicated shapes and available in pipe, rod, sheet and block forms. It has outstanding resistance to both strong and weak organic and inorganic acids, alkalies, alcohol, salt water and sulphite.

Experienced engineering facilities are available to help you decide where and how Boltaron can be used to halt corrosion in your plant. Trained fabricators coast to coast and in Canada will work with you. Write Box 804 for further information.

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Industrial Plastics Division
Park Square Building, Boston, Mass.

Boltaron
6200

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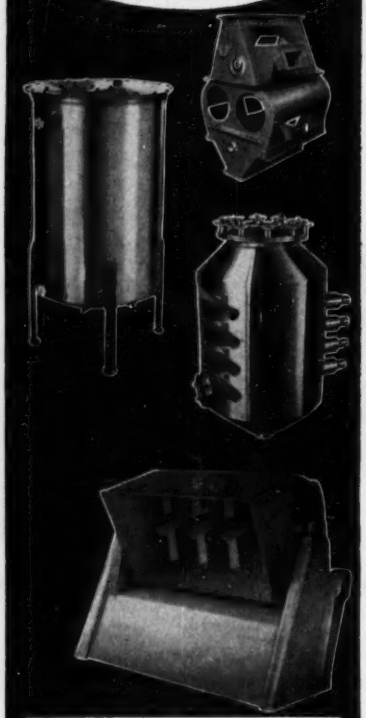

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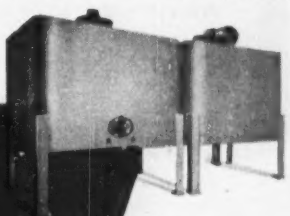
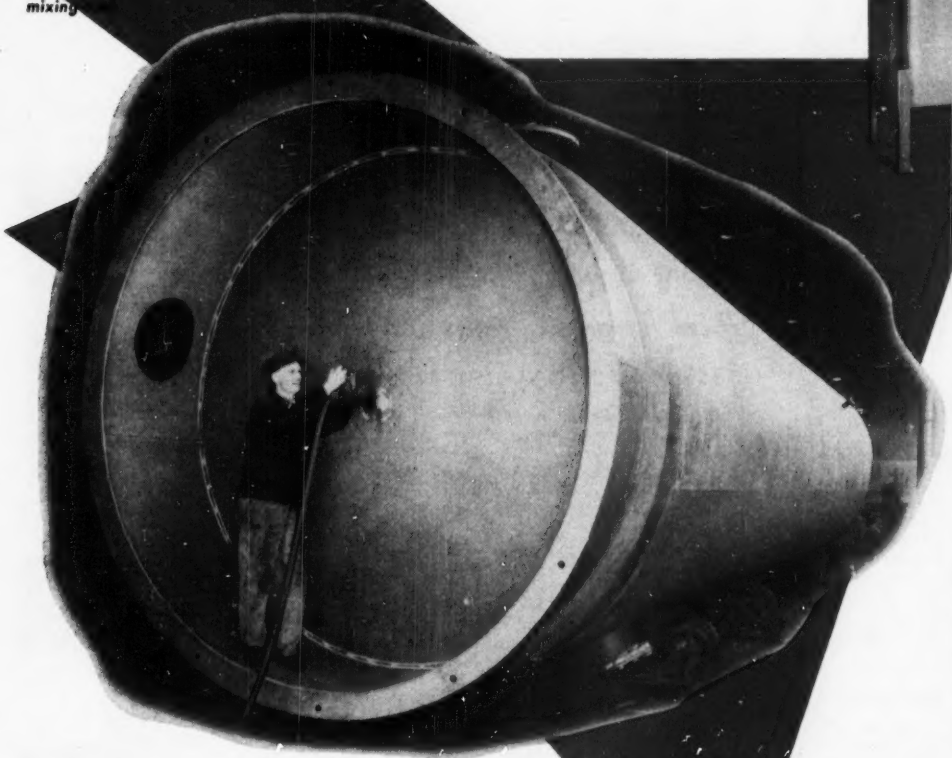
Complete modern facilities including X-ray inspection and stress relieving which insures quality control. KOVEN equipment in all commercial metals and alloys includes: pressure vessels, extractors, mixers, stills, condensers, kettles, tanks, chutes, containers, stacks, breechings, coils. Fabrication to A.S.M.E. Code Par. U-68 and U-69 a specialty.

Stainless steel jacketed mixing



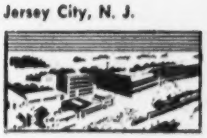
angular mixing tanks de of steel



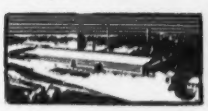
Heavy pressure surge tank

PLANTS:

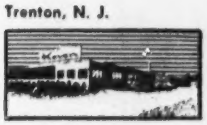
Jersey City, N. J.



Dover, N. J.



Trenton, N. J.



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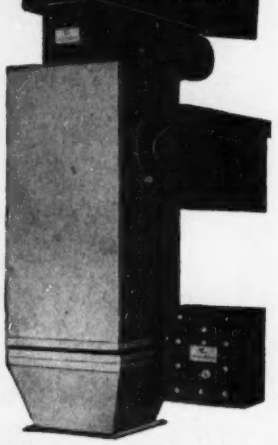

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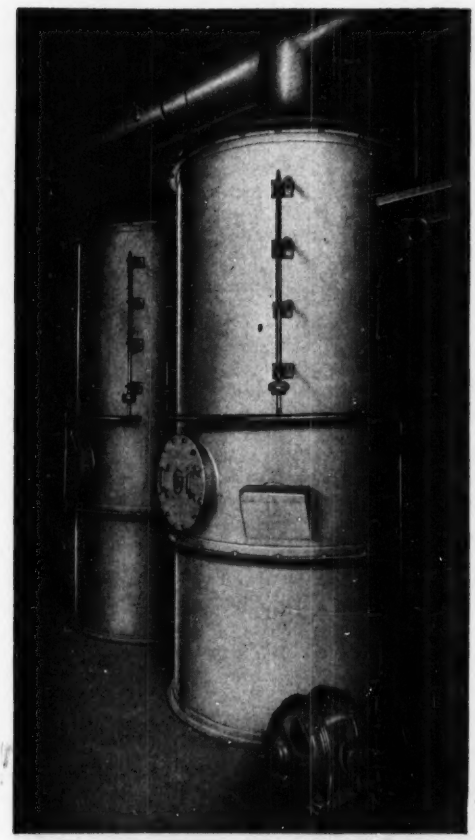

MAHON FOG-FILTERS AT WORK

The installation illustrated above was specially designed for the Motor State Oil & Grease Co., Jackson, Mich. PROBLEM: To eliminate H_2S odor from sulphonated grease manufacturing operations. The problem was complicated by grease and oil fumes present in H_2S gas. SOLUTION: A two-tower Fog-Filter connected in series was designed with high pressure water fog collecting practically all of the grease and oil fumes in the first tower. A caustic solution employed in the second tower and fogged at lower pressure removes the remaining H_2S from the air before it is exhausted into the atmosphere.

In dealing with air contaminants, each individual air cleaning problem must be approached with a view to determining what type of collector or filter is required to produce maximum results under existing conditions. Study and analysis of the character and extent of the polluent is therefore imperative in arriving at a satisfactory solution. Mahon dust and fume control engineers have, over a period of years, developed and perfected special Wet and Dry Collectors and Fog-Filters which have proved highly successful in coping with all types of industrial air contaminants—a few are illustrated here . . . they are serving today in some of the most difficult and mandatory air cleaning jobs in industry. Each installation has been engineered to do the specific job. If you have an air pollution problem, regardless of its character, it will pay you to call in a Mahon engineer and let him show you what Mahon equipment has done with like polluents under conditions comparable to your own. See Mahon's Insert in Sweet's Mechanical Industries File for further information, or write for Industrial Equipment Catalog A-654.

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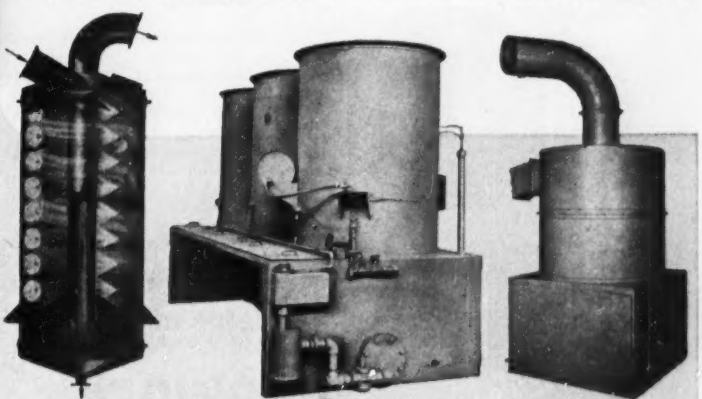
Engineers and Manufacturers of Dust and Fume Control Equipment Including Cyclone Collectors, Hydro-Foam Collectors, Jet Trap Collectors, Hydro-Filter Collectors, and Fog-Filters and Cupola Stack Washers.

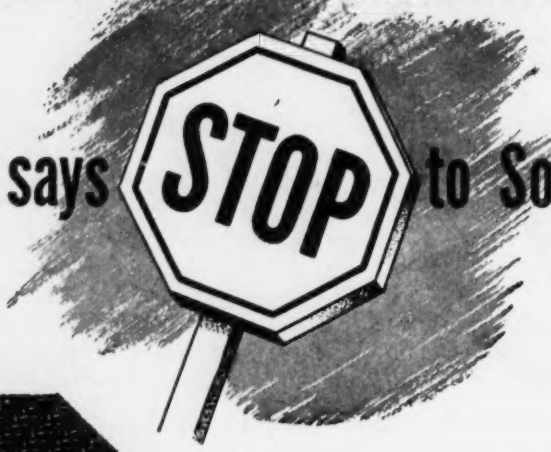
All Mahon Equipment is Erected by Mahon to Insure Complete Satisfaction.



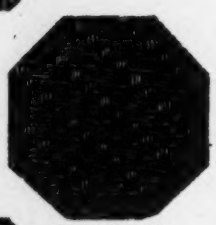
Fog-Filter **Hydro-Foam Dust Collector** **Jet Trap Dust Collector**

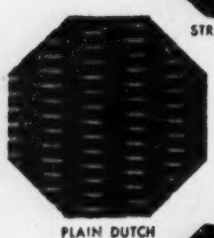
MAHON

Newark Metallic Filter Cloth...

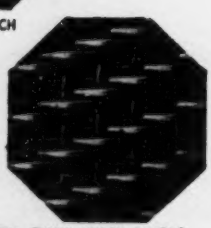


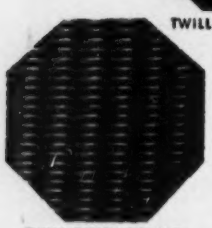
TWILL


STRANDED TWILL


PLAIN DUTCH

Enlarged approximately 3X


TWILL DUTCH SINGLE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Newark Metallic Filter Cloth does stop solids — the wedge-shaped openings allow only the filtrate to pass through. And, Newark Cloth is reversible, both sides being identical. Newark Metallic Filter Cloth is woven firmly and uniformly without loose wires, guaranteeing good filtration all over.

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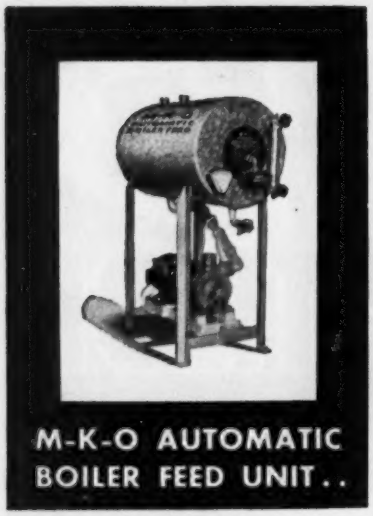

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Returns Condensate and Make-up Water, Keeps Constant Water Level

M-K-O AUTOMATIC BOILER FEED UNITS are designed to *automatically* pump hot condensate, plus any required make-up water, into a boiler, *without manual attention:* to maintain a practically constant water level at the point most economical for highest boiler efficiency; and to supply small quantities of hot water to the boiler at frequent intervals, thus eliminating the steam pressure drop incident to the old method of injecting large quantities of cold water at infrequent intervals. Boiler life is also prolonged by feeding hot water instead of cold water.
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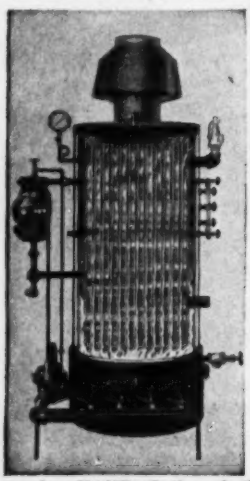

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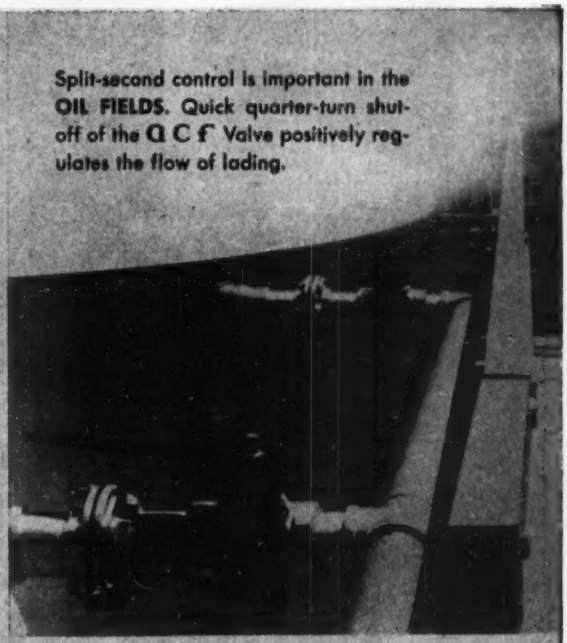

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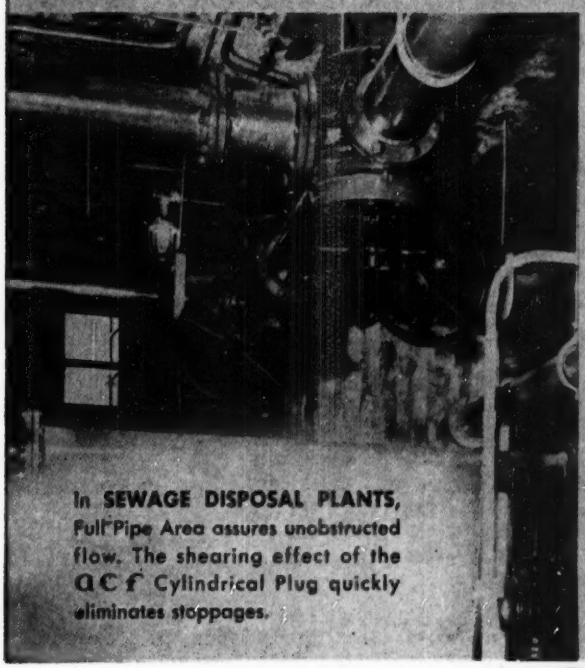

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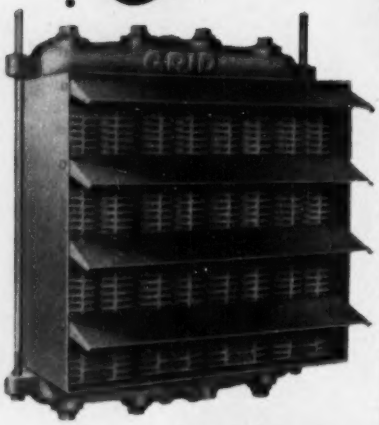

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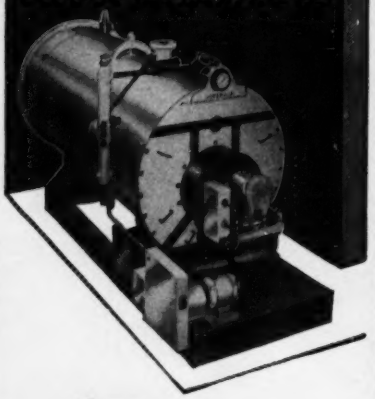

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POWDER FILLERS

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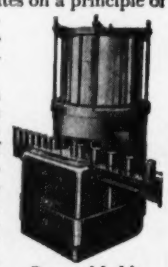
Air is removed from the container to create a vacuum which draws a measured quantity of powder from the hopper. There is no problem with dust control, since the unique Vacuflow method simply does not involve air currents that cause dust.



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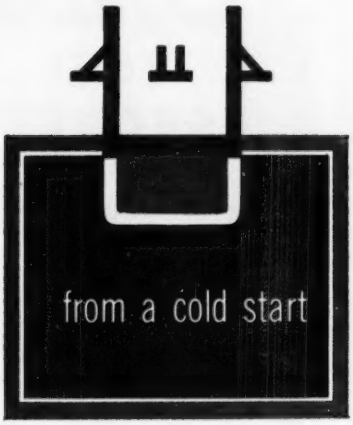

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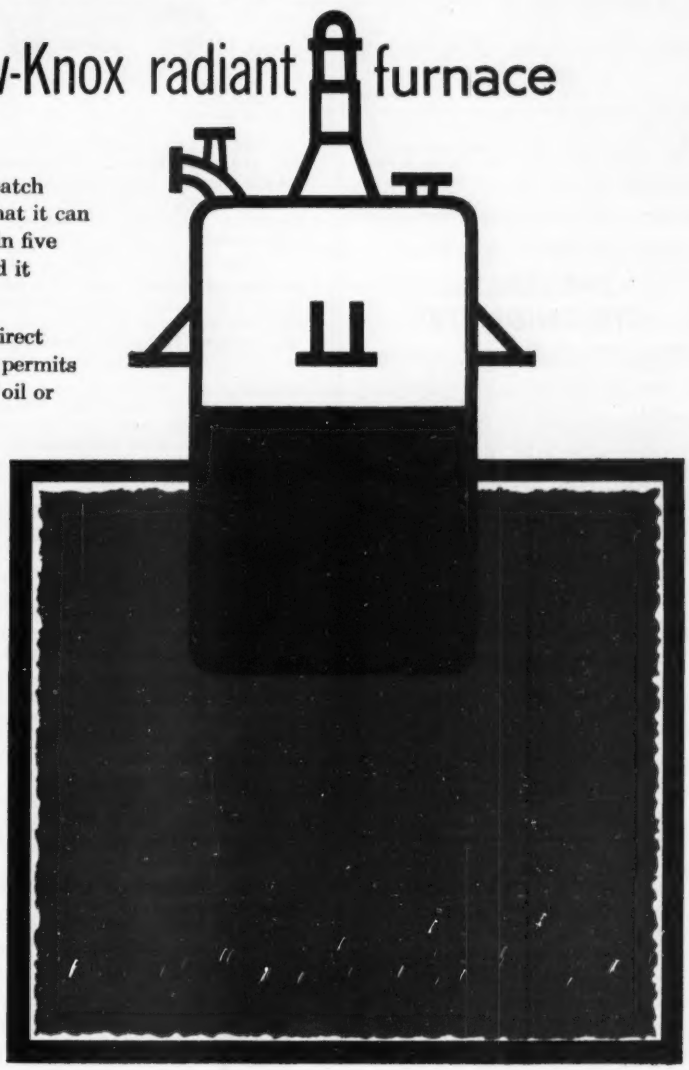

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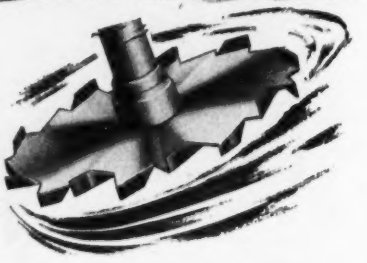

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For complete information on the Cowles Dissolver, write for our FREE CATALOG

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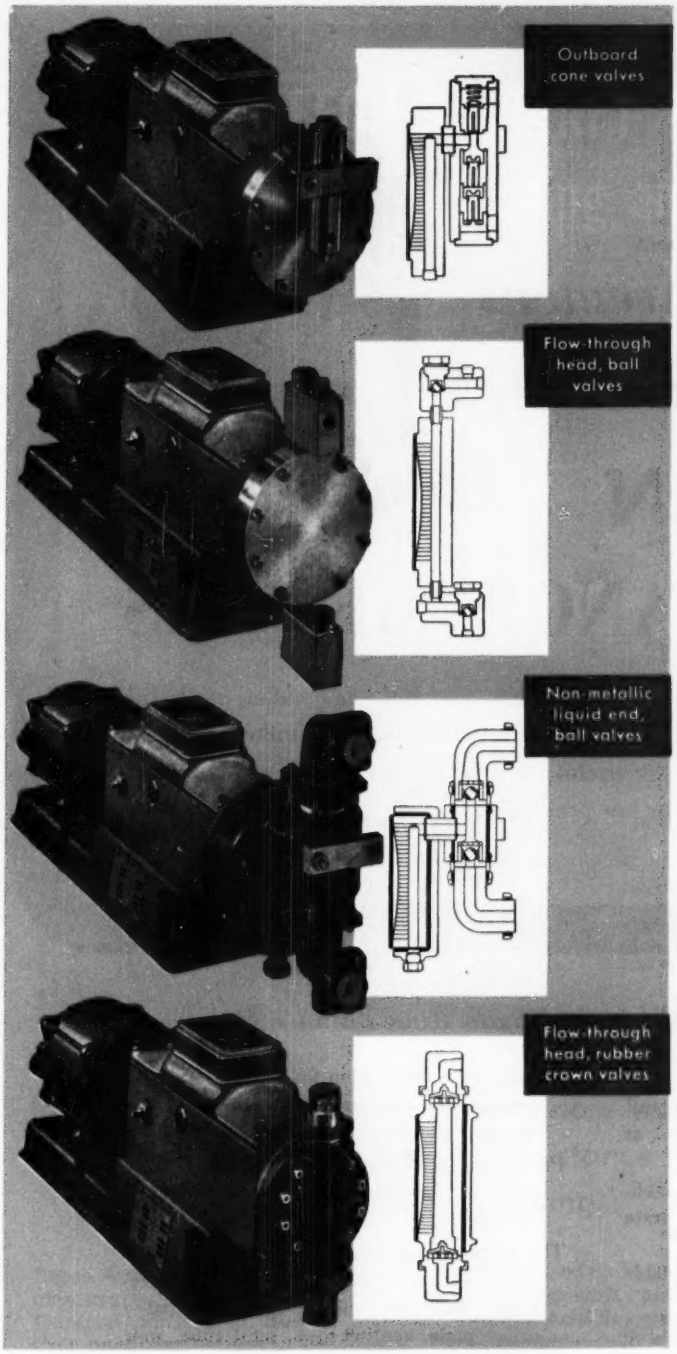

Outboard cone valves
Flow-through head, ball valves
Non-metallic liquid end, ball valves
Flow-through head, rubber crown valves

4 VALVE CONSTRUCTIONS

TO CHOOSE FROM IN

Lapp PULSAFEEDER

PISTON-DIAPHRAGM CONTROLLED-VOLUME CHEMICAL PUMPS

No one valve design or construction is adequate to handle all types of materials which must be pumped in controlled volume. Experience indicates that flow characteristics of fluids are greatly influenced by viscosity, specific gravity, lubricity and temperature; solids in suspension require a special design, whereas low-viscosity, non-lubricating liquids present a wholly different valving problem. Lapp offers the Pulsafeeder in a variety of liquid-end designs, materials of construction, and valve assemblies—four of which are shown here. For your "special problem" in proportioned pumping of liquids, ask us for an engineering recommendation on the Pulsafeeder assembly specifically suited.

WRITE FOR BULLETIN 300 *with typical applications, flow charts, description and specifications of models of various capacities and constructions. Inquiry Data Sheet included from which we can make specific engineering recommendation for your processing requirement. Write Lapp Insulator Co., Inc., Process Equipment Div., 346 Wilson St., Le Roy, N.Y.*

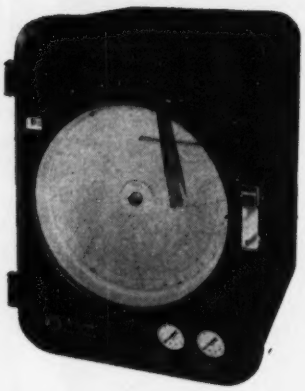
POSITIVE DISPLACEMENT...AND NO STUFFING BOX!

Lapp Pulsafeeder is the combination piston-diaphragm pump for controlled-volume pumping of fluids. Reciprocating piston action provides positive displacement. But the piston pumps only an hydraulic medium, working against a diaphragm. A floating, balanced partition, the diaphragm isolates chemical being pumped from working pump parts—eliminates need for stuffing box or running seal. Pumping speed is constant; variable flow results from variation in piston-stroke length—controlled by hand-wheel, or, in Auto-Pneumatic models, by instrument air pressure responding to any instrument-measurable processing variable.

Lapp

for

Reliable Measurement of low differentials



HAGAN RING BALANCE METERS

Where flow measurements *must* be made with a low full scale differential, the logical choice is the Hagan Ring Balance Meter. This versatile meter, with no external sealing chambers, is equally useful for flow measurements at low differential or high differential, at high or low pressures.

Consider these advantages of the Hagan Ring Balance Meter

Interchangeable sensing elements, in a complete series, are available for measuring full scale differentials from 1″ to 420″ WC, at static pressure up to 3,000 psig.

The ring assembly is selected for each installation to assure ample power for accurate meter operation at all flows.

The differential range of any ring is adjustable over a 7 to 1 ratio.

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Automatic compensation for such variables as temperature, pressure or fluid density is a standard attachment.

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The Hagan Ring Balance Meter is the most versatile design available for flow measurements with any source of differential—orifice plate, venturi tube, pitot tube, weir or flume.

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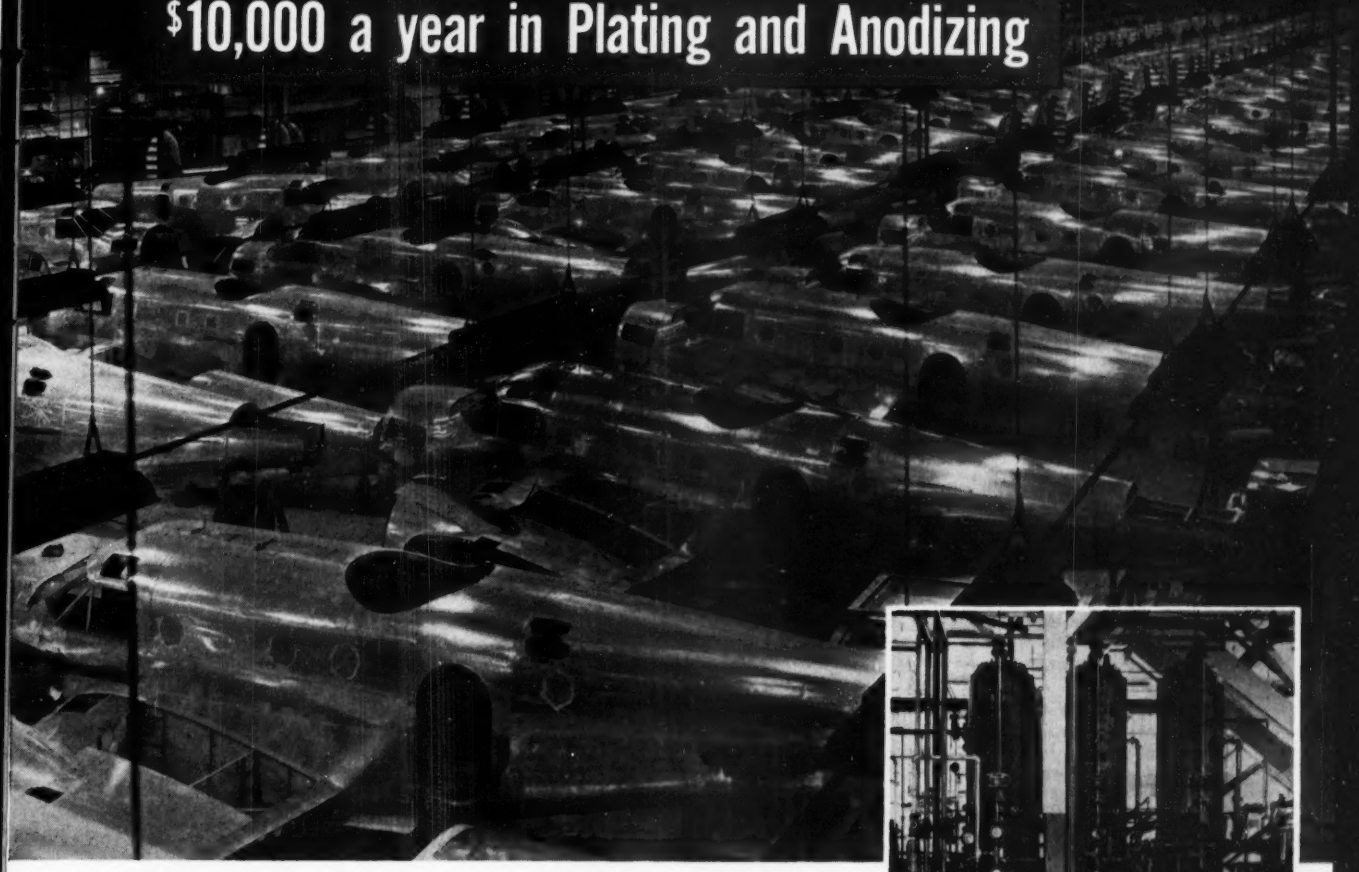

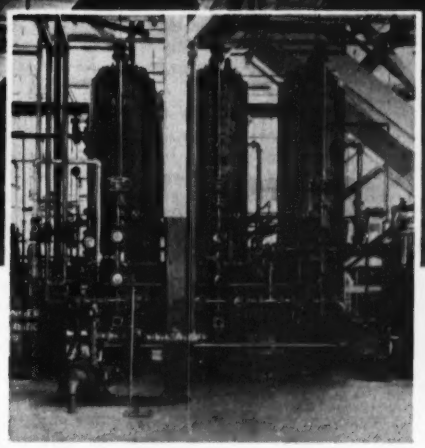

Permutit Ion Exchangers also eliminate waste disposal problem . . . improve resistance to corrosion of anodized coatings.

Beech Aircraft encountered a tough chromate disposal problem. Dumped portions of Beech's 5% CrO_3 anodizing baths plus the rinse flow were sending more than 70 pounds of CrO_3 per day to waste. Immediate action was necessary!

Conventional treatment was no help . . . it takes up too much space, costs a lot. And raises the new problem of sludge disposal.

New Method Investigated! Beech engineers looked into the ion exchange process of chromate treatment pioneered by Permutit. Here's what they got with Permutit's help.

Chromic Acid Savings! Compact Permutit units (above) eliminate pollution. It is no longer necessary to dump any portion of the anodizing baths! The cation exchange unit removes contaminating dissolved aluminum, permits indefinite re-use of the chromic acid.

Improved Corrosion Resistance! The two anion exchange units recover up to 40 lbs. of CrO_3 per day from rinse water. All water is recirculated! It goes back to rinse tanks *mineral-free*, at the correct pH for best resistance to corrosion of the anodized coat.

It's easy to see how this Permutit installation will pay for itself in less than 2 years . . . and why you should let Permutit help you solve your waste disposal problem.

Write to The Permutit Company, Dept. CE-9, 330 West 42nd Street, New York 36, N. Y., or Permutit Company of Canada, Ltd., 6975 Jeanne Mance St., Montreal.

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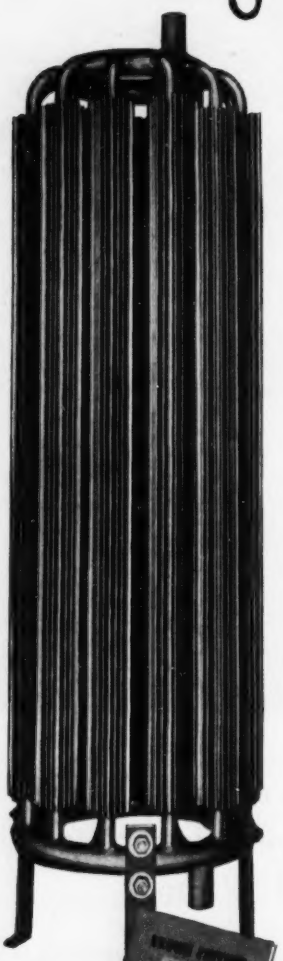
4 reasons why

BROWN FINTUBE TF-18 TANK HEATERS HAVE OBSOLETED OLD FASHIONED TANK COILS



1) **LOWER COST**—Users report that the cost of TF Heaters plus their installation is usually less than the cost of just installing bare pipe coils of equivalent capacity.

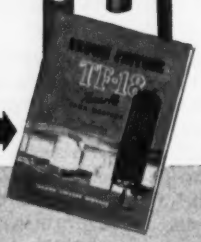
2) **VERTICAL MOUNTING**—on legs about 10" above the tank floor brings the entire heating surface in contact with the tank contents—avoids heating through a layer of sediment.

3) **MUCH INCREASED EFFICIENCY**—Finned construction provides approximately 7 times more heating surface per foot of tube length than plain bare pipe—permits more heat to be transferred—faster—at lower temperatures per square foot of surface, avoiding coking or damage to heat sensitive products.

4) **EASY INSTALLATION**—TF-18 heaters pass easily through a standard manhole permitting installation in new or existing tanks. They do not require welding inside the tank. Manifolded into groups or individually trapped.

You can't keep your operations competitive with old fashioned, obsolete methods. Write today. Get full details about these new, fully proved, less costly, more efficient tank heaters.

New fully descriptive Bulletin No. 541 gives dimensions and full details. Write for your copy today.



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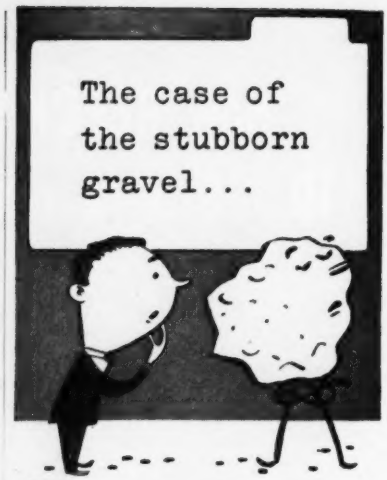
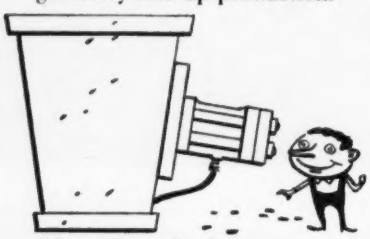


Yes, believe it or not, chaos really reigned in this case of a Washington gravel plant . . . all because of a pile of stubborn gravel.

It bridged . . . it arched . . . it plugged . . . and generally tied up production.



After we got the facts on the case, we recommended a CLEVELAND vibrator, and in nothing flat that stubborn gravel was moving continuously and smoothly.

Tell us your materials handling problem, or ask for our detailed literature.

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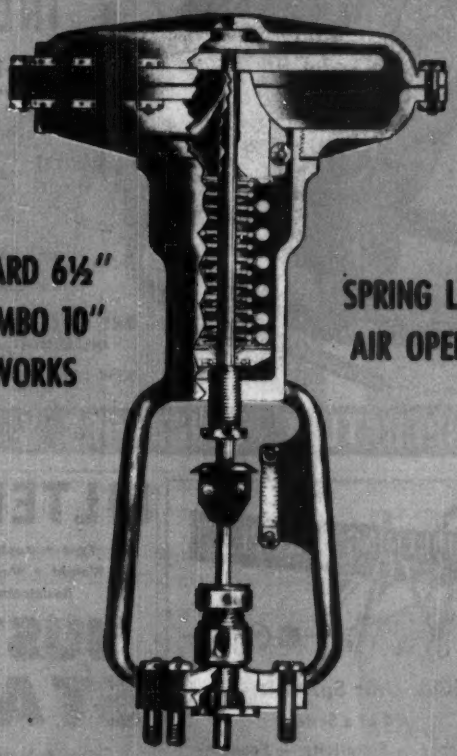
USE BS&B CLIMAX
TYPE 86-TW DIAPHRAGM OPERATORS



STANDARD 6½" OR JUMBO 10" TOPWORKS

SPRING LOADED AIR OPERATED

This versatile Climax Type 86-TW Diaphragm Operator is a modified version of the controlling mechanism of the famous BS&B Climax Type 86 Control Valve. It has been adapted for use with a variety of other valves, instruments and controls such as butterfly valves, diaphragm valves (Saunders Patent), engine throttles and other controls where controlling pressure is available for translation to reciprocating motion.

Available in either the Standard 6½" or Jumbo 10" size, this versatile topworks is spring loaded and operates from compressed air or other medium. Yoke, spring case, diaphragm case and plate are of high tensile cast iron. Stems are of stainless steel with bronze connector of unique construction. Diaphragm is of cotton or nylon neoprene. Roller bearings on the spring guide reduce friction loss to a minimum.

For more complete information on the Climax Type 86-TW Diaphragm Operator or on other Climax Controls, ask your BS&B Man or Sales Representative, or write to . . . .

CLIMAX BS&B CONTROLS OVER 60 YEARS

BLACK, SIVALLS & BRYSON, INC.

Climax Controls Division Dept. 4-N9

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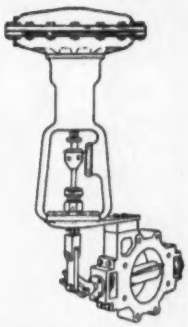
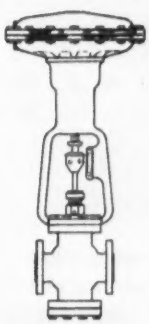


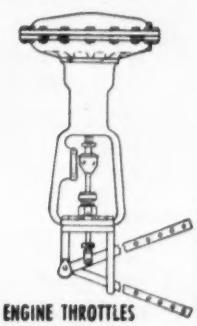
FOR BUTTERFLY VALVES

Climax Type 86-TW Diaphragm Operator is ideal for automatic control of butterfly valves. Mounts easily on any make of valve, and can be set for any specified operation of the valve.



FOR DIAPHRAGM VALVES

First developed for use on diaphragm valves, Climax Type 86-TW Diaphragm Operator has large diaphragm area and variable spring loading to insure minimum hysteresis.



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Wherever a sensitive yet positive reciprocal controlling motion is needed, such as on engine throttles, speed governors, cooling tower weirs, valve levers, etc., the versatility and adaptability of the Climax Type 86-TW Diaphragm Operator make it the ideal selection.

the *ACID* TEST of time will prove the value of

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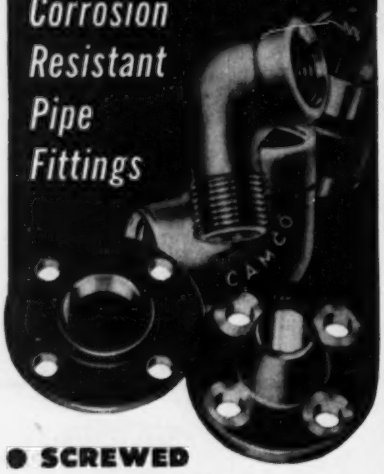

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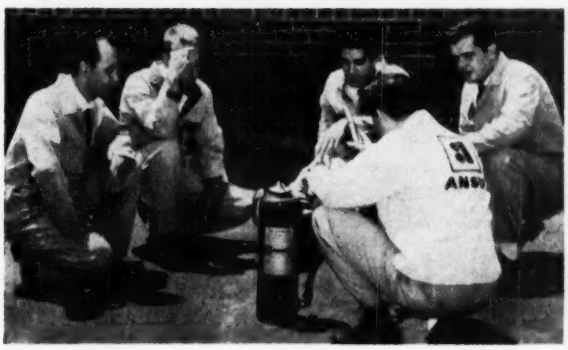

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VISUAL AIDS for your safety meetings designed to make all your employees fire-control conscious.

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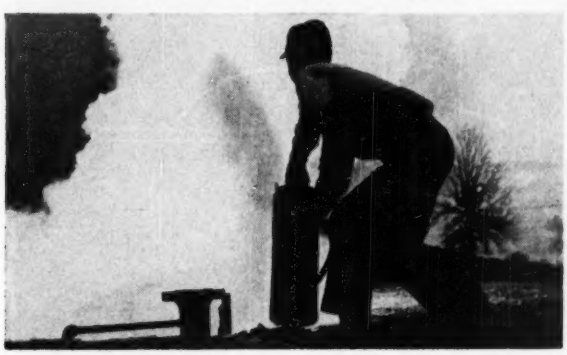

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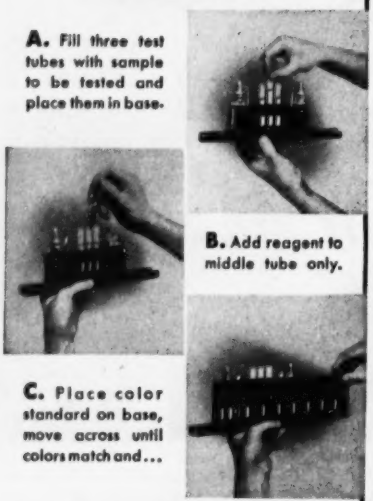
Make Accurate
pH, CHLORINE TESTS
this simple way



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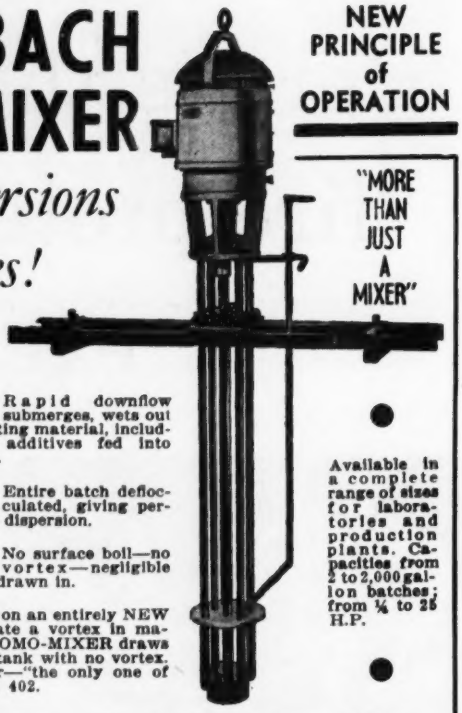
NEW PRINCIPLE of OPERATION

1 *makes dispersions*
2 *homogenizes!*



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2. Inflowing "slurry" violently agitated at high velocity, projected up toward surface.

3. Submerged baffle plate deflects rising current toward tank sides, thence down toward bottom.

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5. Entire batch deflocculated, giving perfect dispersion.

6. No surface boil—no vortex—negligible air drawn in.

This mixer is built and operates on an entirely NEW principle. Ordinary mixers create a vortex in material, pull air into tank. The HOMO-MIXER draws only from the BOTTOM of the tank with no vortex. Write for details of this mixer—"the only one of its kind". Ask for Catalog No. 402.

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ADMIRAL TOOL & DIE CO., INC.
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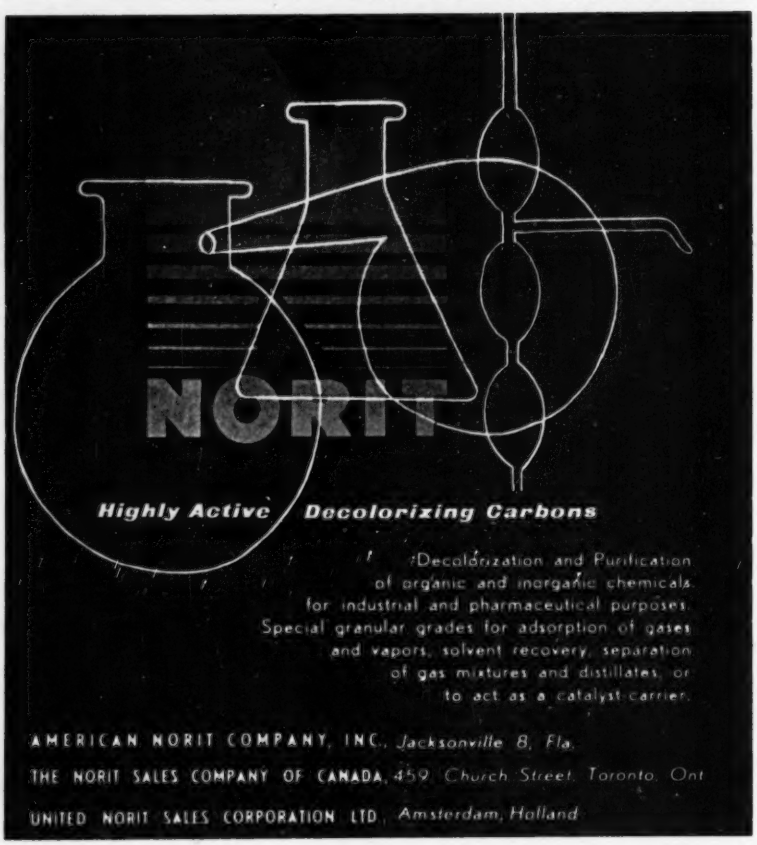


Highly Active Decolorizing Carbons

Decolorization and Purification of organic and inorganic chemicals for industrial and pharmaceutical purposes. Special granular grades for adsorption of gases and vapors, solvent recovery, separation of gas mixtures and distillates, or to act as a catalyst carrier.

AMERICAN NORIT COMPANY, INC., *Jacksonville 8, Fla.*
THE NORIT SALES COMPANY OF CANADA, 459 *Church Street, Toronto, Ont.*
UNITED NORIT SALES CORPORATION LTD., *Amsterdam, Holland*

Will your process lines CHOKE to death?

When you install Chase Copper Water Tube–you can be *sure* of process lines that will not clog with rust.

The clean, smooth interior surface of Chase Copper Water Tube does not restrict the flow even of heavy industrial fluids like paper pulp. Pumping costs are kept to a minimum.

And because Chase Copper Water Tube can be joined with leak-proof Chase *solder-joint* Fittings, your system stays *pressure-tight*–eliminating costly repairs and replacements.

Chase Copper Water Tube is easy to install, will pay its own way with years of rustproof service. Get more information by contacting your nearest Chase Wholesaler or Chase warehouse listed below.

Chase Copper Tube keeps a clean, clear cross-section, even after years of service in a paper mill.

Get pipe that can't *choke up with rust. Get Chase Copper Water Tube and keep pumping costs down.*

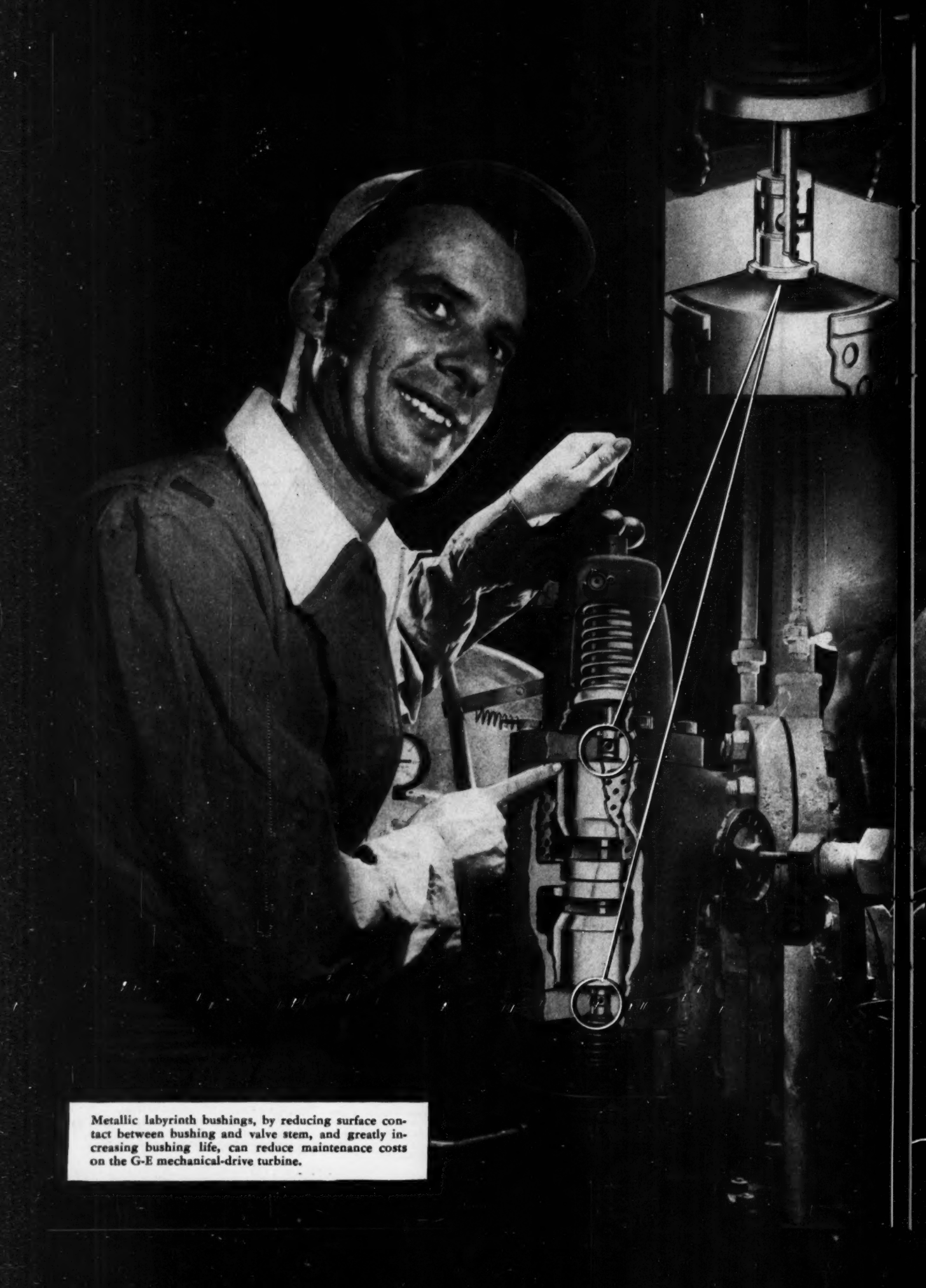
Chase®

BRASS & COPPER CO.

WATERBURY 20, CONNECTICUT • SUBSIDIARY OF KENNECOTT COPPER CORPORATION

The Nation's Headquarters for Brass & Copper

Albany†	Chicago	Denver †	Kansas City, Mo.	Newark	Pittsburgh	San Francisco
Atlanta	Cincinnati	Detroit	Los Angeles	New Orleans	Providence	Seattle
Baltimore	Cleveland	Houston	Milwaukee	New York	Rochester†	Waterbury
Boston	Dallas	Indianapolis	Minneapolis	Philadelphia	St. Louis	(†sales office only)



Metallic labyrinth bushings, by reducing surface contact between bushing and valve stem, and greatly increasing bushing life, can reduce maintenance costs on the G-E mechanical-drive turbine.

ANOTHER PLUS VALUE OF G-E MECHANICAL-DRIVE TURBINES...

Metallic Labyrinth Bushings Cut Turbine Maintenance Costs

Using metallic labyrinth bushings instead of soft packing on the throttle valve stem and operating valve stem of General Electric's Type DP mechanical-drive turbine has several important advantages. Corrosive attacks on the valve stems, often caused by soft packings, are prevented.

Because surface contact between bushing and valve stem is reduced to a minimum, friction is practically eliminated—bushing life is increased tremendously. This feature alone can save you up to $50.00 in direct maintenance costs—plus the expense of down-time caused by frequent packing replacements.

HERE'S ANOTHER ADVANTAGE. Since frictional drag on the governing system is reduced to a minimum, you get more accurate, sensitive, reliable governing with G.E.'s Type DP turbine.

Metallic labyrinth bushings make an effective steam seal by means of grooves in the bushing which throttle pressure and minimize any steam leakage (see illustration).

THESE METALLIC LABYRINTH BUSHINGS are just one of many DP features which save you money throughout total turbine life. The chart below indicates other areas of savings.

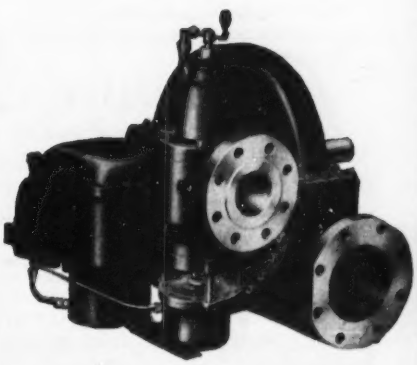
Remember—the total cost is often more than just the sales price. But G.E.'s standard DP turbines include the extra features that save you extra costs. For more information contact your nearest G-E apparatus sales office. Write for bulletin GEA-4955A, "A New Standard in Mechanical-drive Turbines." General Electric, Schenectady 5, N.Y.

252-66

GENERAL ELECTRIC

INSTALLATION AND MAINTENANCE COST-SAVING FEATURES

THESE EXTRA FEATURES, STANDARD ON ALL G-E TYPE DP TURBINES, CAN . . .	Save You up to
COMBINED TRIP-THROTTLE VALVE Eliminate extra cost of buying and installing valve ahead of the turbine.	$200.00
SINGLE RESERVOIR FOR COOLING LUBE OIL Eliminate extra cost of piping cooling water to and between bearings.	50.00
MAJORITY OF PARTS INTERCHANGEABLE One set of spare parts protects several units—less money tied up in inventory.	100.00
METALLIC-LABYRINTH VALVE STEM BUSHING Eliminate labor costs of replacing soft packings; cut down-time production losses.	50.00
SHAFT MONEL-SPRAYED AT PACKING FIT Saves frequent cost of purchasing and installing carbon rings; contributes to long shaft and packing life.	20.00
ESTIMATED TOTAL SAVINGS	$420.00

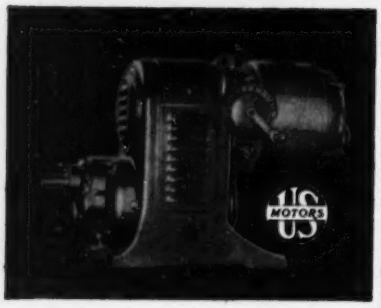


G-E Type DP Mechanical-drive Turbine

COMPARE THE FEATURES
EVALUATE ALL THE COSTS

See why G-E Standard Type DP turbines are your most economical buy.

THOUSANDS OF PLANTS NOW GETTING THOUSANDS OF SPEEDS



Miracle Motor

ANY RPM BY DIAL CONTROL

Get more production out of your present machines by powering them with U. S. Varidrive motors. No extra space required. Thousands of plants are profiting with this miracle motor. Turning a simple control handle changes speed of the Varidrive to any desired r.p.m. in ratios up to 10:1. Operators can instantly select the speed best suited for the work.

ALL-IN-ONE PACKAGE

Occupies little more space than a single speed motor. ¼ to 50 hp, 2 to 10,000 r.p.m.

U.S. VARIDRIVE

Mail Coupon for New 16-pg. Booklet

REQUEST FOR VARIDRIVE BOOKLET

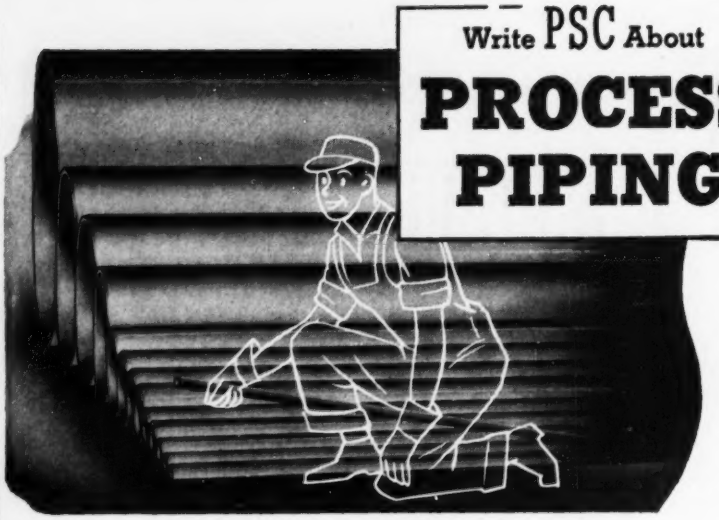
U. S. ELECTRICAL MOTORS Inc. CE-9
Box 2058, Los Angeles 54, Calif. or Milford, Conn.

Name_____

Company_____

Address_____

City_____ Zone____ State_____



Write PSC About PROCESS PIPING

Fabricated from Complete Range of Alloys, Any Diameter Up to 60", and in Any Shape

PSC welded process tubing is furnished in any alloy whatsoever. This feature accounts for its wide application in meeting the unlimited variety of heat, corrosion, oxidation conditions in process plants.

Any diameter up to 60"; wall thicknesses to 3/8"; temperatures to 2200°. Precision fabrication of tubing assemblies is a specialty. Send b/p or write as to your needs.

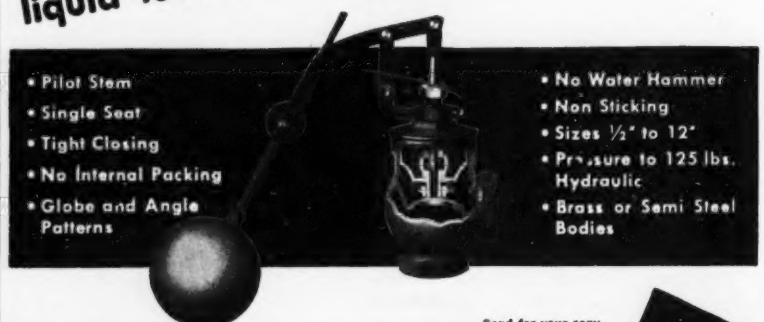
THE PRESSED STEEL CO., 707 N. Penna. Ave., Wilkes-Barre, Pa.

PRESSED STEEL PSC

Custom Fabricators for the Process Industries Since 1928. Send Your Blue Prints

DAVIS FLOAT VALVES

For more efficient liquid level and flow control



- Pilot Stem
- Single Seat
- Tight Closing
- No Internal Packing
- Globe and Angle Patterns
- No Water Hammer
- Non Sticking
- Sizes ½" to 12"
- Pressure to 125 lbs. Hydraulic
- Brass or Semi Steel Bodies

The complete line of Davis Float Valves offers a wide variety of units for almost any given service. These valves are simple in construction, rugged in service, and accurate in operation. You get efficient control with low overall expense. Davis float valves require less maintenance, preventing costly shutdowns. Let us give you complete service recommendation. Write today!

Send for your copy of Bulletin 101-B featuring Balanced Valves, Pilot Valves, Float Valves and Motor Valves

Davis REGULATOR CO.

2539 S. Washtenaw Avenue Chicago, Illinois

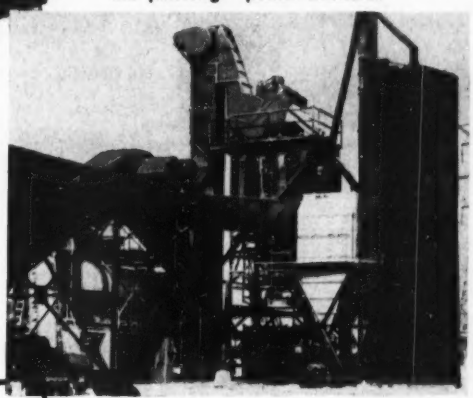
DUST in ... it's PROFIT

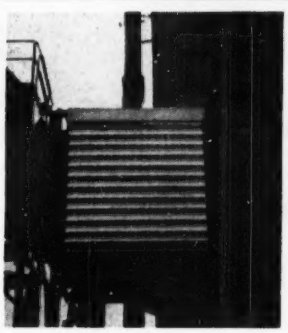
In the air ... it's LOSS

A Dustex Collector can mean the difference between collecting valuable dust at a profit . . . or, discharging it to the atmosphere at a loss. Dustex Collectors are serving the chemical industry in many diversified applications . . . all proving "profit makers."

This installation saved $9450.00 in one year!

Operating as a secondary collector on a kiln drying operation, this Dustex D-52 Collector handles fines about the size of face powder — all will pass through 325 mesh — at a temperature of 225° F. at 32,000 cfm. Collection efficiencies for this unit are 94.6% with a recovery of 1630 pounds per hour of dry useable material, with a value of approximately $9.00 per ton. With the plant running 175 days a year the Dustex Collector recovers material valued at $9450.00.





DUSTEX COLLECTOR Model D-52

The Dustex D-52 Collector without upper and lower hopper sections and inspection panels shows one of the tube banks. Tube arrangement is flexible to meet space requirements.

Efficiencies as high as 100% at 14 microns are obtainable with Dustex Collectors. This plus their efficiency at high temperatures and ability to handle fine, coarse, light, heavy, hygroscopic, dry, wet, fibrous or corrosive materials has made possible their use in applications where mechanical collectors were heretofore impractical.

HIGH EFFICIENCY
LOW MAINTENANCE
DRY, MECHANICAL
DUST COLLECTION

dustex CORP.

BUFFALO 25, NEW YORK

This valuable booklet tells you how a Dustex Determination Test can help YOU balance your books on your dust losses. It describes in detail the test method Dustex Corporation has devised to accurately determine the savings you can accrue. This test, made in your own plant under actual operating conditions, gives you actual Dustex efficiency before installation of equipment. For profits by the bag or barrel, send coupon for this brochure today.

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1754 Walden Ave.
Buffalo 25, N. Y.

Gentlemen:
Please send your brochure describing the Dustex Test Method.

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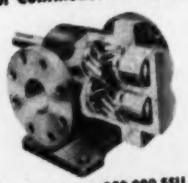
Sier-Bath ROTARY PUMPS

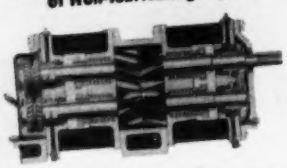
CUT COSTS with these ADVANCED DESIGNS

"HYDREX"—Low Cost Gear Pump for Continuous Heavy Duty



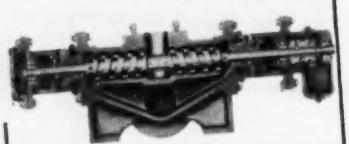
Range: 32 SSU to 250,000 SSU... 1-500 GPM . . . 300 PSI for continuous duty, 500 PSI for intermittent service.

"GEAREX"—For Low Cost Pumping of Non-lubricating Liquids



Range: 32 SSU to 1,000,000 SSU . . . 1-550 GPM . . . 250 PSI for viscous liquids, 50 PSI for water.

SCREW PUMPS—Most Dependable for Non-lubricating Liquids



Range: 32 SSU to 1,000,000 SSU . . . 1-1000 GPM . . . 1000 PSI for viscous liquids, 500 PSI for water.

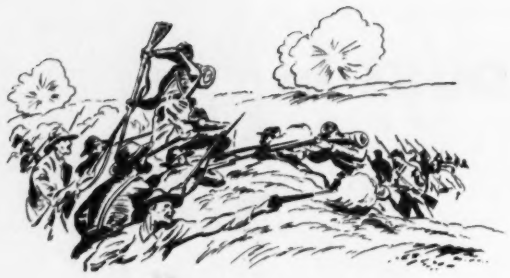
SIER-BATH GEAR & PUMP CO., INC.
9259 Hudson Blvd., North Bergen, N. J.

Please send information on:
☐ "Hydrex" ☐ "Gearex" ☐ Screw Pumps

Name.....
Title.....
Company.....
Address.....
City.....
Zone..... State.....

Founded 1905 Member A.G.M.A. Also mfrs. of Precision Gears and Flexible Gear Couplings

1854 R.D. COLE Centennial 1954

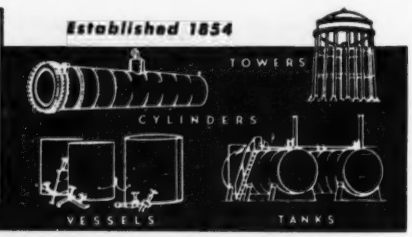


TEN YEARS before the BATTLE OF ATLANTA

In 1854, ten years before the Battle of Atlanta, we started out as a small iron-works. Many communities and many mills secured their first elevated tanks for water supply from us. For the privilege of celebrating our Centennial, we express our appreciation for the friendship of four generations of customers, and the loyalty of four generations of workers.

R.D. COLE
MANUFACTURING CO.
NEWNAN, GA.

Established 1854



ACROSS THE NATION....

BART LECTRO-CLAD

Steel Plate, Pipe and Fittings Give Permanent Corrosion Protection at LOW COST!

Hundreds of firms, including pulp and paper, petroleum, chemical processing and other industries have solved critical contamination and corrosion problems, with BART LECTRO-CLAD.

HERE ARE SOME OF THE MAJOR ADVANTAGES OF LECTRO-CLAD PRODUCTS

- **ECONOMY** . . . thickness of nickel tailored to particular applications.
- **TROUBLE-FREE** . . . combination of structural strength of steel and protective qualities of nickel assures positive life long protection with minimum maintenance.
- **PERMANENT** . . . Does not require periodic replacement or repair. Will withstand elevated temperatures and abrasion.
- **VERSATILE** . . . can be sheared, welded or fabricated into all types of processing equipment, storage vessels. LECTRO-CLAD withstands any fabricating process that can be withstood by conventional rolled steel.

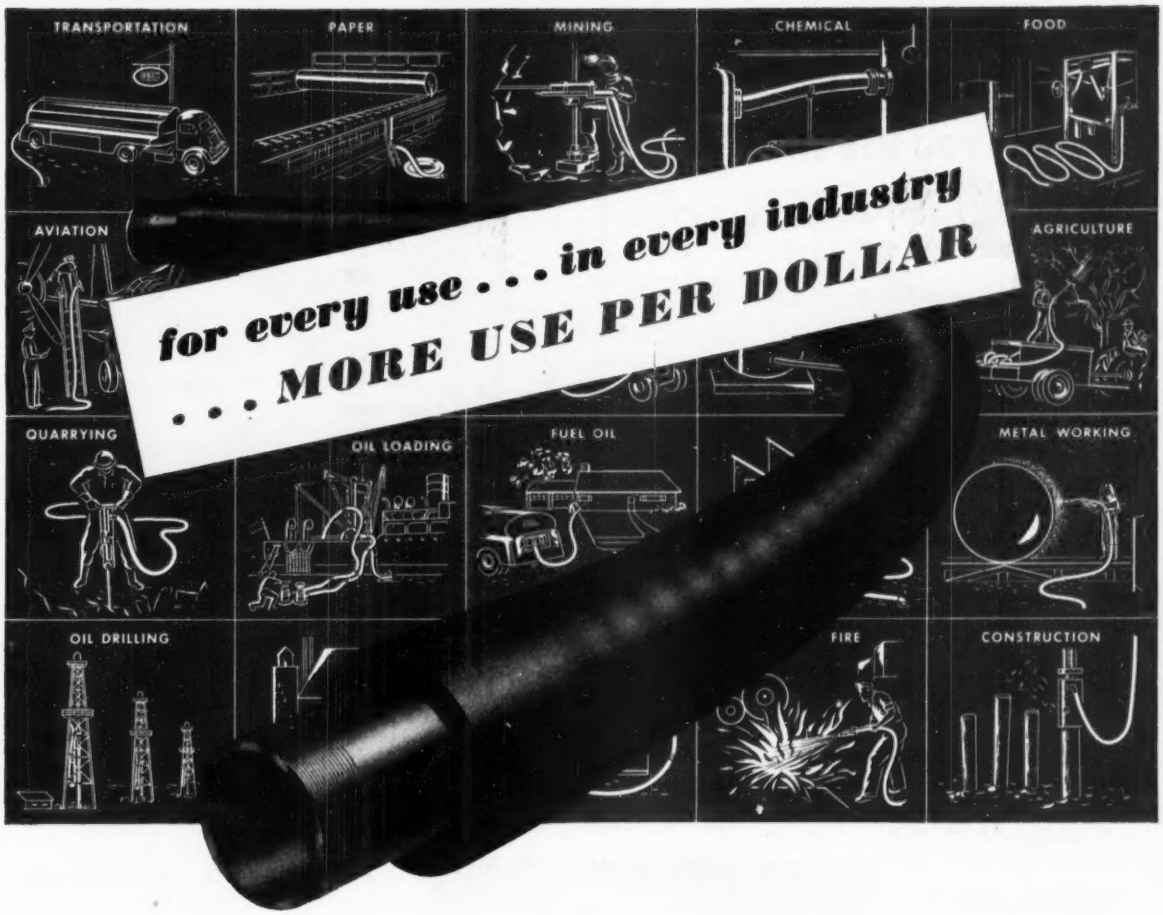
LECTRO-CLAD PIPE available in sizes from 1½" to 54" in diameter, 20-foot random lengths.

LECTRO-CLAD SHEET and PLATE available in thicknesses from 11 gauge to ¾", 7 feet x 20 feet.

Write Dept. CE-9 for complete details and technical data.
Names of LECTRO-CLAD users on request.

BART MANUFACTURING CORPORATION
229 Main Street Belleville 9, New Jersey

Exclusive territories available to qualified distribution organizations.

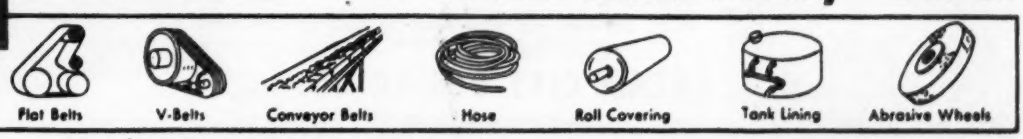


R/M HOSE Raybestos-Manhattan makes the world's largest and strongest suction hose for conveying sand, water, oil, and sludge materials faster and more efficiently . . . at lower cost. R/M hose constructions range from ¼" paint spray hose to huge dredging hose big enough for a man to crawl through. Whatever your hose requirements – for handling air, water, steam, chemicals, gases and fluids of any kind – R/M hose will do your job better . . . because it's designed and engineered to last longer for each specific use. If you have a hose problem, Manhattan has the solution . . . over sixty years research and engineering experience assure you "More Use per Dollar" from every length you buy. You'll find the same is true of R/M conveyor belts, V-belts, flat transmission belts and other rubber products for your industry. Consult an R/M representative.

RM

MANHATTAN RUBBER DIVISION—PASSAIC, NEW JERSEY

RAYBESTOS-MANHATTAN, INC.



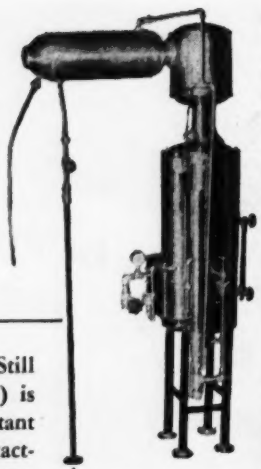
Other R/M products include: Industrial Rubber • Fan Belts • Radiator Hose • Brake Linings • Brake Blocks • Clutch Facings
Asbestos Textiles • Packings • Engineered Plastic, and Sintered Metal Products • Bowling Balls

NO IMPURITIES POSSIBLE

WHEN YOU USE THE

NP WATER STILL

(NON-PYROGENIC)



The outstanding feature of every NP Water Still (aside from dependably economical operation) is the fact that no impurities can enter. The resultant distillate is PURE, and suitable for the most exacting and critical needs. This is the result of careful engineering design, the use of the SINGLE COILED TUBE condenser, and the NP Impurity Discharger. The NP Water Still is the most advanced still on the market today.

Steam Heated Stills up to 250 gal. per hour
Electrically heated type, up to 10 gal. per hour.
Gas Heated, up to 50 gal. per hour.
Complete details and specifications promptly available.

CONSOLIDATED MACHINE CORP.

Manufacturers of

Stills, Sterilizers, Autoclaves, Hospital and Laboratory Equipment

Water Demineralizers

39 SUDBURY ST., BOSTON 14, MASS.

HIGHEST QUALITY

SUPERIOR CRAFTSMANSHIP

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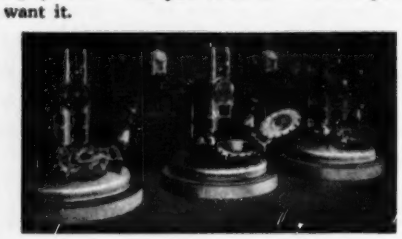
CHEMICAL PROCESSING EQUIPMENT FOR PILOT PLANT OR PRODUCTION

FABRICATORS OF PRESSURE VESSELS PROCESSING TANKS STORAGE TANKS AGITATOR KETTLES COLUMNS • STILLS HEAT EXCHANGERS IN STAINLESS STEEL • NICKEL STAINLESS AND NICKEL CLAD MONEL • INCONEL SILICON BRONZE CARBON STEEL ALUMINUM

Flexible facilities accommodate individual designs for pilot plant or production. Equipment built in a variety of sizes and finishes to your exact requirements.

Superior Craftsmanship

For over half a century Cream City Boiler Company has been a recognized leader in the fabricating field. Today our experienced craftsmen and versatile methods give you more dependable, economical, high quality equipment — as you want it — when you want it.



Our engineers will assist you in the selection of the most economical design for your requirements.

WRITE OR WIRE FOR NAME AND ADDRESS OF NEAREST REPRESENTATIVE.

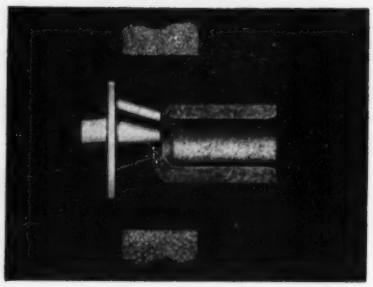
CREAM CITY BOILER CO.

1604 SOUTH 43rd STREET

MILWAUKEE 46, WISCONSIN

WHY

'Surface' burners improve heating processes



Tunnel burners, single or twin-nozzled, assure you of complete and rapid combustion within the tunnel.

Thousands of 'Surface' burners, in the chemical industries, have speeded up and improved many heating processes because they:

1. **Save fuel** with automatic proportioning.
2. **Simplify control equipment** with one-valve operation.
3. **Increase the range** of operating temperatures with high turndown ratio.
4. **Increase safety** with a design which mixes gas and air at or near the burner—explosive mixtures piped very short distances.
5. **Save time** in adjustment with easy-to-change spuds and inserts.

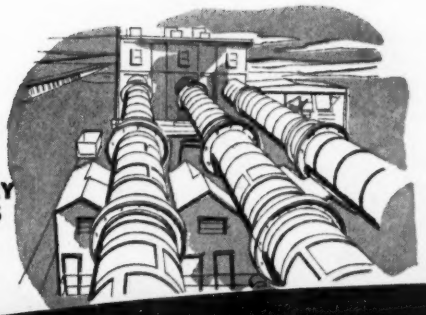
Select the right equipment from 80 types and 800 sizes completely described and rated in the 'Surface' catalog. Stop waste and start savings soon —call your 'Surface' engineer or write for Literature H54-16.

Surface

BURNER EQUIPMENT

SURFACE COMBUSTION

CORPORATION, TOLEDO 1, OHIO

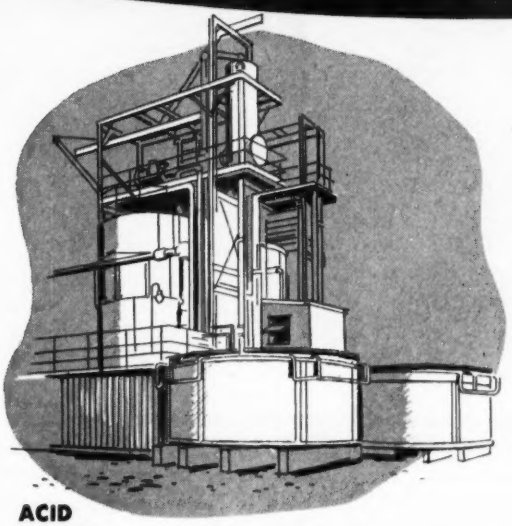


ROTARY KILNS

Harbison-Walker

REFRACTORIES

for every type of chemical processing furnace . . .



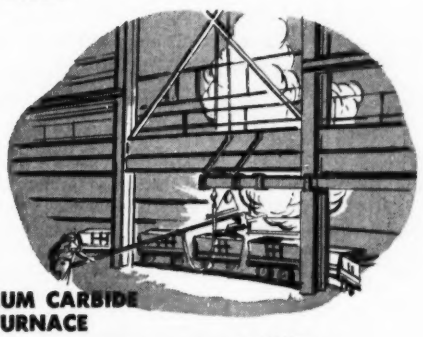
ACID TOWER

In many chemical processing operations, high temperatures, spalling conditions, abrasive action and chemical attack combine their individual destructive factors to impose exceptionally severe treatment on refractory linings in kilns, roasters and other types of furnaces.

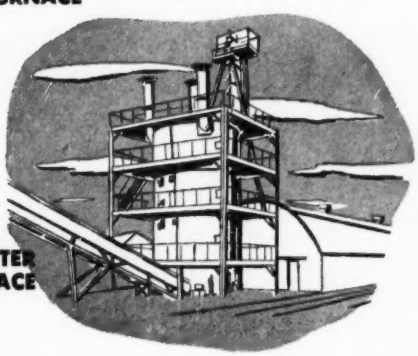
To meet the wide variety of conditions that exist in chemical processing applications, Harbison-Walker offers a complete line of refractories from which can be selected the exact types and brands needed for longest life and most economical service in every part of the furnace.

For acid towers, tank linings, floors and various chemical resistant constructions, Duro and W-Acid brands fulfill the most severe requirements.

Our Technical Service Department will be glad to make specific recommendations for your requirements.



CALCIUM CARBIDE FURNACE



ROASTER FURNACE

HARBISON-WALKER REFRACTORIES COMPANY

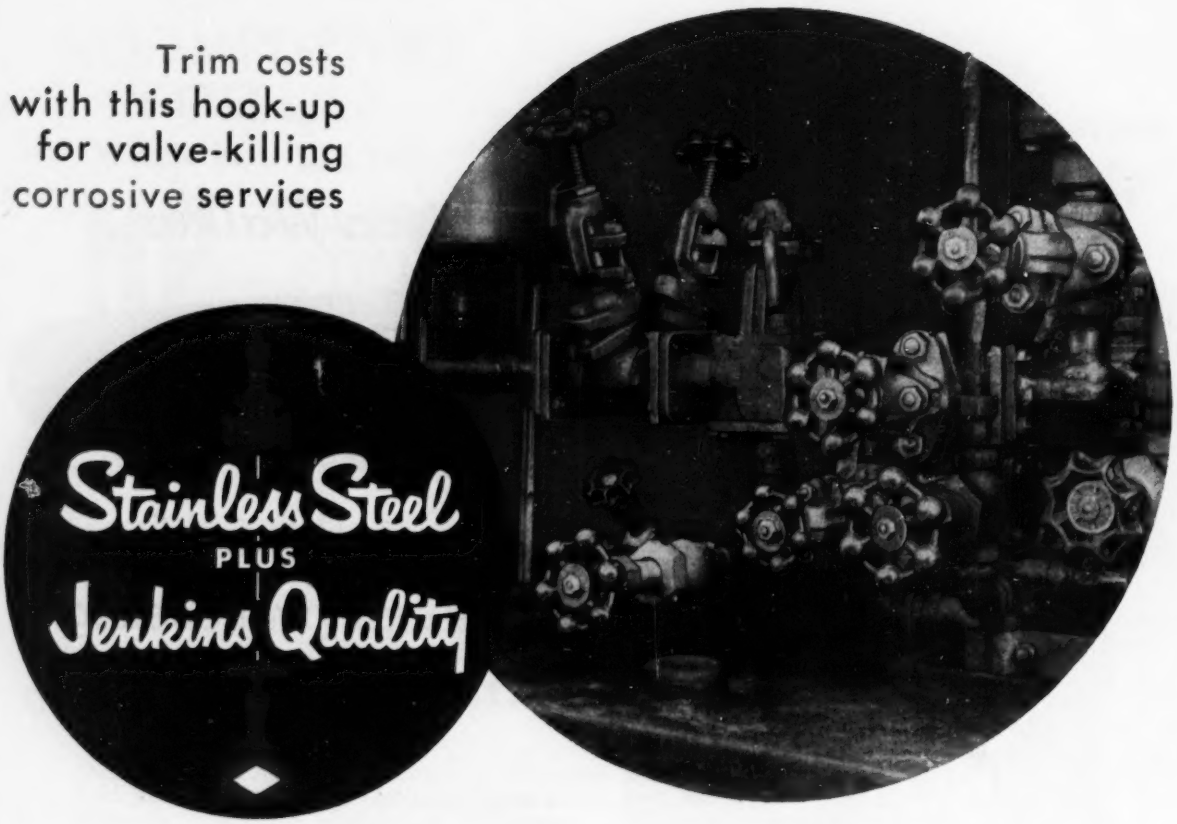
AND SUBSIDIARIES

World's Largest Producer of Refractories

GENERAL OFFICES

PITTSBURGH 22, PA.

Trim costs with this hook-up for valve-killing corrosive services



To end high valve mortality from most corrosive liquids, and to control fluids that must be kept free from contamination or discoloration, stainless steel is the right metal. But it takes more than metal to make a valve. For dependable performance, you need the two-way hookup — Stainless Steel *and* Jenkins time-proved Valve Engineering.

With the increased demand for processing equipment that resists corrosion, more and more Stainless Steel Valves have been added to the Jenkins line. It now includes types, designs, sizes and alloys to meet practically all industrial needs.

Let the famous Diamond trade-mark be your guide when you choose valves of stainless steel. As on *any* Jenkins Valve, it means *extra value* . . . longer, trouble-free service life.

NEW BOOKLET describes the wide range of types, sizes, pressures, and alloys available in Jenkins Stainless Steel Valves, with diagrams and dimensions. Includes description of alloys, helpful information on selection, and survey forms. Ask for Form 200. Jenkins Bros., 100 Park Ave., New York 17.

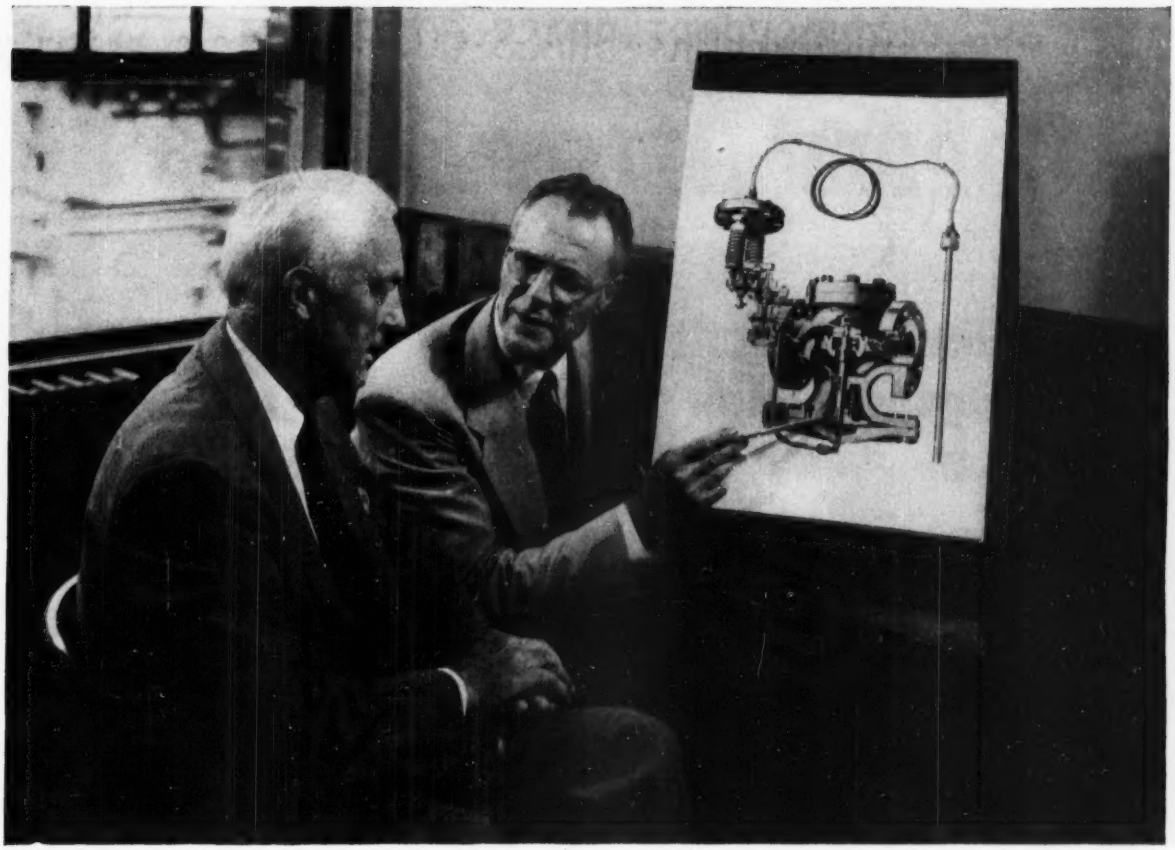
JENKINS VALVES

LOOK FOR THE JENKINS DIAMOND

SINCE 1864 TRADE JENKINS MARK

Jenkins Bros.

SOLD THROUGH LEADING INDUSTRIAL DISTRIBUTORS EVERYWHERE



How to Select an Economical Temperature Regulator

First of all, what does *economy* mean where temperature regulators are concerned? In some industries it means improvement of product or reduction of spoilage through closer control of process temperatures. In others, it means the paring down of operating expense. The price of the regulator itself is a relatively small factor.

Today's buyers are shopping for:

1. Accuracy of control — not only when the regulator is new, but throughout its service life
2. Dependability — to prevent loss of production time
3. Minimum installation and maintenance cost

Here are a few tips on what to look for when you're installing a new or replacing an old temperature regulator —

Packless construction . . . and for this reason: A diaphragm operated, packless regulator minimizes friction. There are no closely fitted parts to stick or bind because of uneven expansion or collection of foreign matter. Also, there's less maintenance, since no repacking is ever required.

A guarantee against wire drawing of the seats and discs. Insist on it. This guarantee in combination with single seat design assures you of tight shutoff; you avoid expensive steam losses as well as loss of product in a process application.

Broad control range. In a standard regulator you should expect a control range of 100 F. And make sure the unit you select has a vapor tension thermostat that can take over-temperatures of at least 100 F.

Easy maintenance. Why ask for grief? Your temperature regulator should be basically simple in design so that it can be serviced by average plant personnel. All parts should be readily accessible for testing and cleaning.

Double duty. There's no point in buying a separate pressure regulator when you can select a temperature regulator that combines both temperature and pressure control within the same unit.

Self-operating. Make sure you get a regulator that operates on its own initial pressure. By doing so, you avoid the purchasing and maintenance of an air compressor plus air piping, and you're sure of uninterrupted operation during electric power failures.

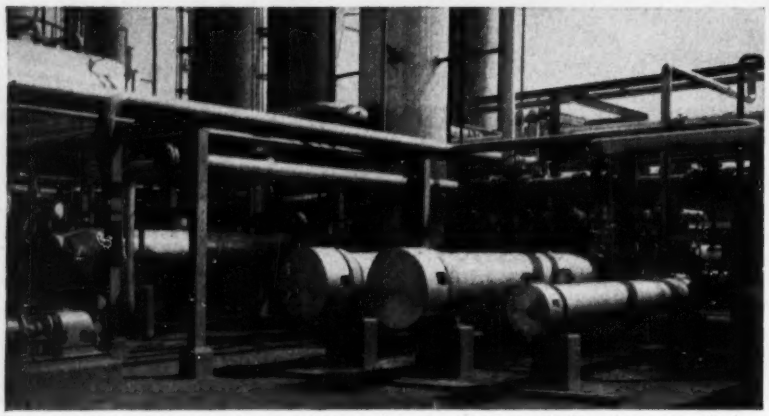
• • • •

All of these points are important to you when it comes to selecting an economical temperature regulator. Perhaps you didn't realize you *could* expect so much. And perhaps you didn't realize that *Spence* Temperature Regulators offer all these features and more. May we send you our Bulletin T 500 containing further details? SE 130

SPENCE ENGINEERING COMPANY, INC.
Walden, New York

BRIDGEPORT BRASS COMPANY
CONDENSER AND HEAT EXCHANGER TUBE EDITION
COPPER ALLOY BULLETIN
Bridgeport MILLS IN BRIDGEPORT, CONN. AND INDIANAPOLIS, IND. — IN CANADA: NORANDA COPPER AND BRASS LIMITED, MONTREAL

How to Benefit with Bridgeport Duplex Tubes



Bridgeport Duplex Tubes in condensers and heat exchangers mean longer tube life and greater production.

The list of new petroleum and chemical products grows by leaps and bounds every year. And a variety of new corrosion problems is always close behind. Many new and useful end products, derivatives and intermediate fluids require careful selection of condenser and heat-exchanger tube alloys, particularly those with specific corrosion-resistant properties to insure long tube life and greater efficiency. A wide increase in cooling water pollution and a trend toward greater utilization of salt and brackish waters have added heavily to the burden of tube performance. Corrosive attack from both product and cooling water on single-alloy tubes often results in premature failure from attack by one media or the other. Bridgeport Brass has solved many such double corrosion problems by drawing two specially selected alloys concentrically together into double-walled Duplex Tubes.

The use of Duplex Tubes in operations subject to different types of inside and outside corrosion offers many advantages.

Longer Service Life

The alloys selected for Duplex Tubes are each chosen for their specific capacity to handle one particular corrosive media. Admiralty Low Carbon Steel Duplex Tubes for a cooler handling benzol liquid and sea water are an example. In this case, Admiralty has excellent corrosion resistance to sea water while the low carbon steel carries benzol liquid well. A tight mechanical bond joins the two concentric tubes at a metal-to-metal interface. Each alloy is exposed to corrosion on only one surface, that facing the media it was selected to handle. Thus each alloy can perform to the full extent of its service capacity without exposure to attack from the second media. This fact spells longer service life and lower long-term tube cost.

Lower Maintenance Costs

When tubes are made of alloys specially chosen to handle specific corrosive fluids, it is possible to predict much more closely how long the tubes will perform before they require cleaning or replacement. It isn't necessary to shut down expensive continuous operations for premature repairs. Duplex Tubes, with alloys that match the media, will often reduce the frequency of tube replacement and cleaning maintenance costs.

Improved Products

Single-wall tubes are often made of a compromise alloy—one that will give the best possible resistance to corrosion from both inside and outside media. The result can be contamination of a highly refined or carefully balanced product. With Duplex Tubes no such compromise is necessary. The alloy facing the product and the alloy facing the cooling or heating media are both chosen on the basis of their compatibility to their respective fluids. An excellent example of the above is the use of Duplex Tubes made up of Stainless Steel/Copper, or Aluminum/Copper for equipment used to process food products, pharmaceuticals and fine chemicals.

Increased Production

Bridgeport Duplex Tubes, in some cases, have higher heat-transfer efficiency than tubes of a single metal. For example, Duplex Tubes made of copper and steel used in an ammonia condenser will give greater operating efficiencies than plain steel tubes, due to the absence of an insulating layer of rust and/or organic fouling from algae and slime on the copper cooling-water side.

Greater Safety

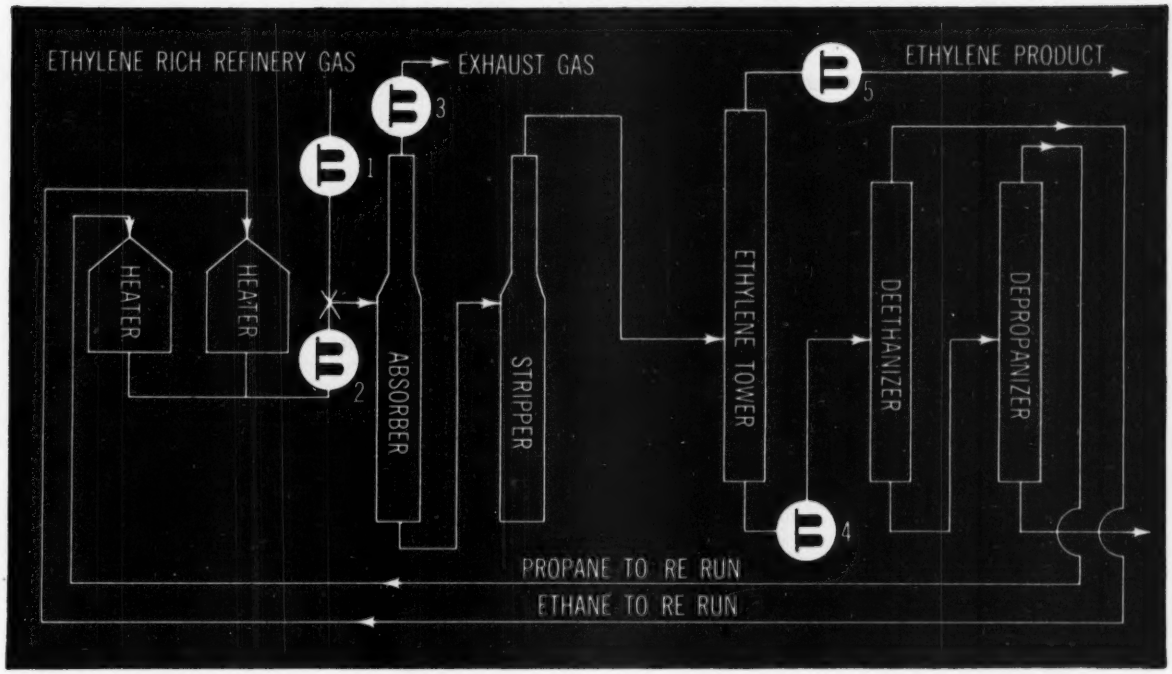
Condenser and heat-exchanger tubes are subject to mechanical stress in operation. The force of flowing fluids, operating pressures and temperatures, and the stress of thermal expansion put added burdens on tube walls. By using Duplex Tubes in such combinations as Admiralty/Steel, Aluminum/Copper, and Monel/Red Brass, the best qualities of strength and resilience, as well as heat conduction and corrosion resistance, are contributed by each metal.

Call on Bridgeport for Service

To find out how you can use Bridgeport Duplex Tubes to your advantage, call your local Bridgeport office. Bridgeport's Technical Service or Corrosion Laboratory is always ready to help you select the right Duplex combination for your service conditions. (2156)

Ask for a copy of Bridgeport's Duplex Tube Technical Bulletin. You'll find it a valuable guide to the selection and installation of Bridgeport Duplex Tubes.

TRUE CONTROL BEGINS WITH ANALYSIS...



Ethylene purity guaranteed through use of Tri-non® Analyzers

Even though many elements of process stream environment – temperature, pressure, flow-rate – are under control, a chemical process may not be operating at peak efficiency and product quality suffers.

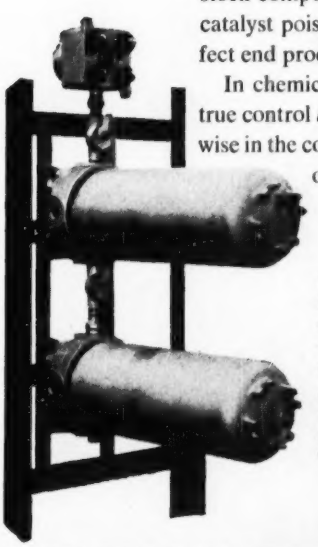
Why?

Because, environmental control gives no indication of basic stream changes like feed stock composition, loss in stripper efficiency, catalyst poisoning, etc., all of which may effect end product quality.

In chemical processing, it is essential that true control *begin* with analysis–either batch-wise in the control laboratory, or continuously on the process stream itself.

In the ethylene purification shown above, purity and maximum recovery is guaranteed by infrared analytical control at five points: 1–Ethylene analysis on feed stock for accounting purposes and process control; 2–Ethylene analysis beyond crackers; 3–Ethylene analysis of absorber off-gas for absorber efficiency; 4–Ethylene analysis in ethylene tower bottoms for fractionation tower efficiency; 5–End-point analysis for ethylene purity.

Let Perkin-Elmer engineers show you how your process can benefit through ANALYTICAL CONTROL–made possible with infrared plant stream analyzers.



Both the TRI-NON *and* BICHROMATOR Analyzer *continuously record the concentration of any desired stream component. Each is sensitized and adjusted to specific plant conditions before shipping.*

THE PERKIN-ELMER CORPORATION
8 Main Avenue, Norwalk, Conn.

Gentlemen:

☐ Send information on the application of infrared analytical control to the following process problem:

.....

☐ Send literature on your infrared plant stream analyzers

☐ Have a sales engineer call

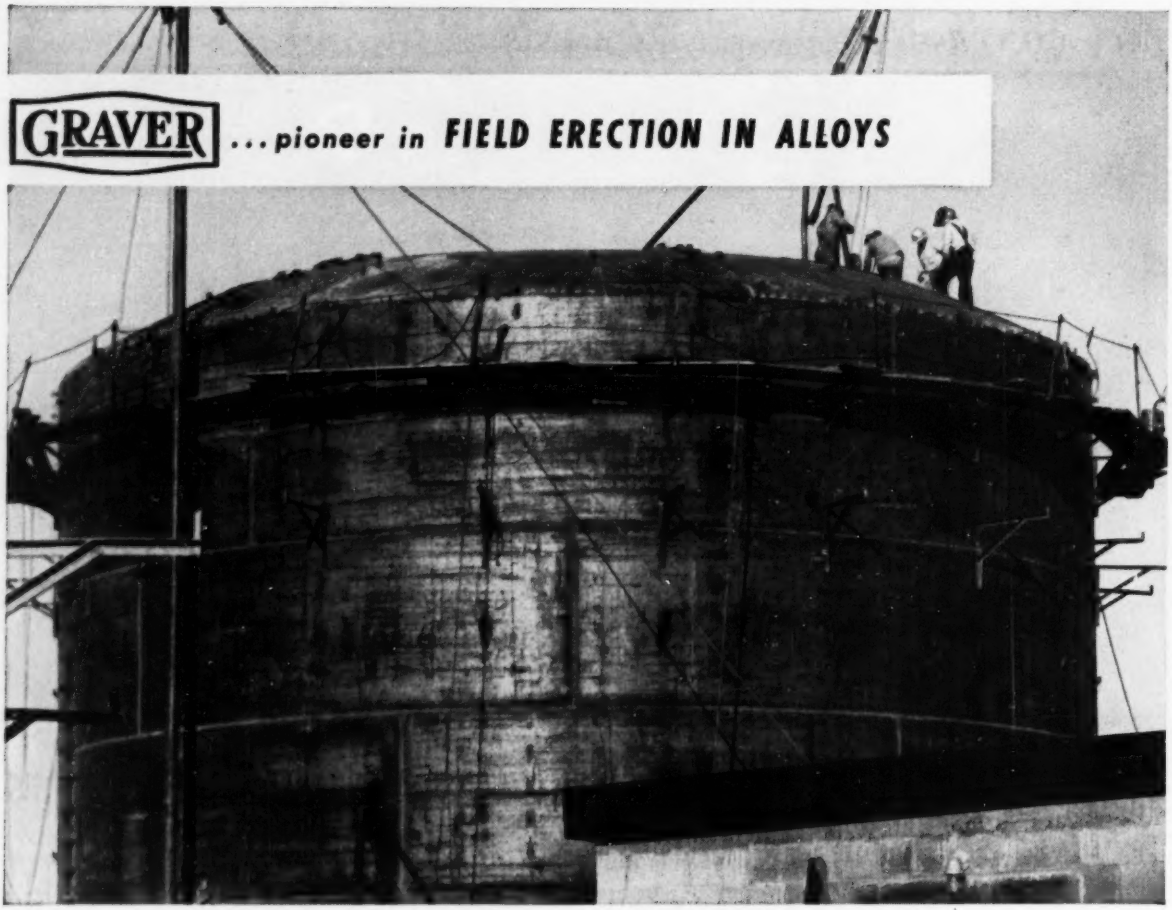
Name ..... Title .....

Company .....

Address .....

PERKIN ELMER — *FIRST IN ANALYTICAL CONTROL*

GRAVER ... pioneer in FIELD ERECTION IN ALLOYS

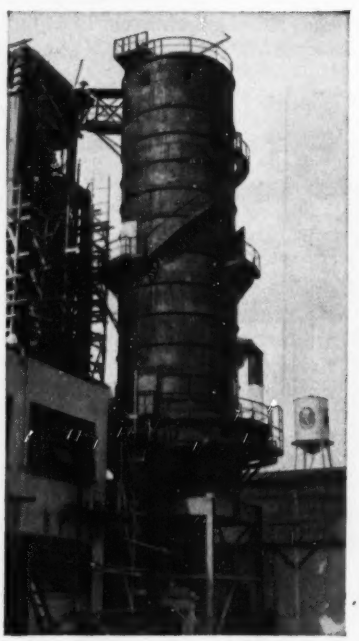


When Seeking a Source...

Consider the wealth of experience Graver has gained in field erection in alloys . . . experience that dates from the birth of alloys. It is standard procedure for Graver to build large, site-erected tanks, towers and process vessels of every size and description—like the large nickel-clad tank for storing caustic shown above, and the intricate spray tower on the right.

Both in this country and abroad, Graver has acquired a reputation for fine craftsmanship, plus a unique ability to more than satisfy customer demands.

For all industries—chemical, petroleum, food, pharmaceutical—Graver fabricates in nickel, stainless, clads and aluminum, as well as in carbon steels. Precision work, painstaking care, intensive inspection methods—these are integral parts of the Graver method. Taken together, they mark Graver as a source worthy of your consideration.



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and Back . . . in an ACME Weldment

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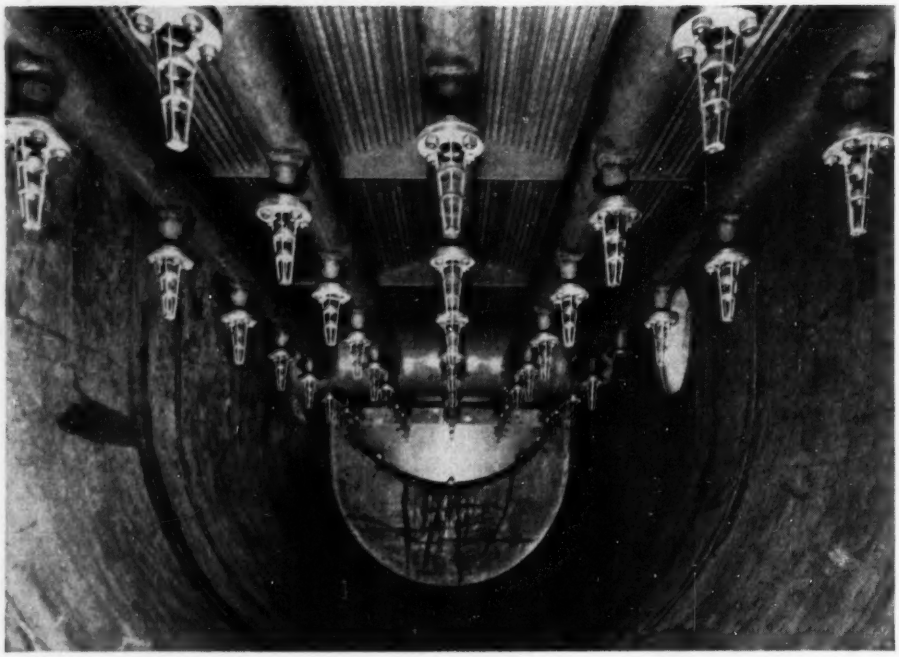
Carpenter Stainless Tubing Gets the Call



For Long-Life...Easy Maintenance

When job conditions are tough and maintenance costs are critical—you can follow the lead of thousands of chemical processing plants and equipment manufacturers and call for Carpenter Stainless Tubing.

The flash cooler pictured here is an example. Carpenter stainless gives the manufacturer more than corrosion resistance. It also has uniform wall thickness; tight adherence to strict physical specifications; unexcelled quality, from length to length and order to order.

It adds up to the fact that there is a cost-saving difference in stainless tubing and pipe and Carpenter makes that difference. Put this provable difference to work for you. Call Carpenter for prompt delivery and any engineering or design help you may need.

The Carpenter Steel Company, Alloy Tube Division, Union, N. J.
Export Dept.: The Carpenter Steel Co., Port Washington, N. Y.—"CARSTEELCO"

Carpenter
Stainless Tubing & Pipe

AUTOMATIC

100% SATURATED

ALWAYS READY TO USE

"Push Button" BRINE

When You Want It . . .
Where You Want It . . .
With Lower Handling Costs

So simple you'll wonder why it wasn't thought of years ago. So sound and practical, it fits any and all types of operations. Write, and our representative will show you how the LIXATE Process adapts to *your* plant. No cost, no obligation.

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One Simple Installation . . .
HERE'S HOW THE LIXATOR WORKS

1. Sterling Rock Salt is stored right in the hopper of the Lixator. Automatically, it feeds by gravity to the—

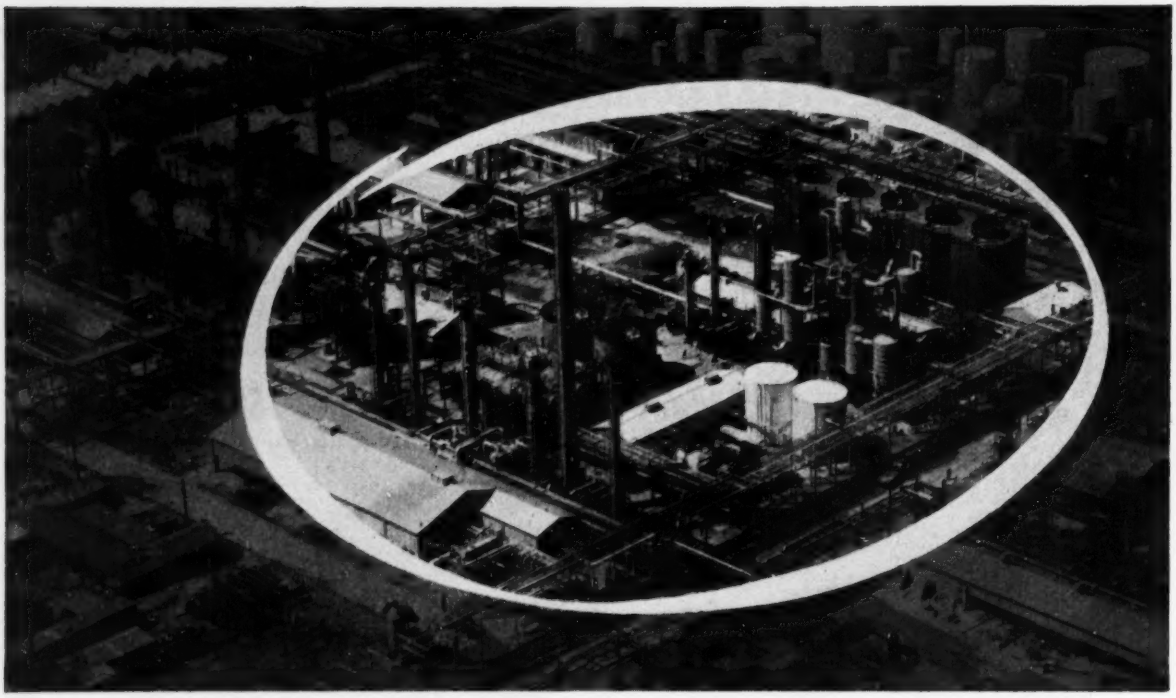
2. Dissolution Zone where water dissolves the rock salt to make 100% saturated brine.

3. Gravity then filters the brine through a bed of *un*dissolved rock salt and—

4. it flows, or is pumped, through the pipes directly to where you need it.

The **LIXATE*** *Process*
FOR MAKING BRINE

*Reg. U. S. Pat. Off.



In this circle purity is an absolute must

...so is Nickel— and here's why

You are looking at a section of Shell Chemical Corporation's Deer Park, Texas, plant.

There, Shell synthesizes glycerine from propylene, with allyl chloride as an intermediate. There, too, the glycerine is evaporated, purified of salt, steam-stripped, distilled and stored.

All this means corrosion and purity problems. Chlorine and propylene are reacted at a temperature which greatly accelerates corrosive attack . . . salt is present in the crude product . . . and there are strict limits on the heavy metals content of glycerine.

Yet Shell successfully combats corrosion to turn out a colorless, odorless product that assays better than 99% glycerol and meets all the usual specification requirements.

How does Shell do it?

With Inconel; in mixing jets for reacting propylene and chlorine at about 950°F. Inconel combines resistance to both heat and corrosion.

With Nickel-Clad Steel; in evaporators, distillation columns, storage tanks . . . wherever glycerine is concentrated. Nickel-Clad Steel combines the protection of Nickel with the economy of steel.

With Monel; in continuous centrifugal filter equipment used to remove sodium chloride by-product. Monel gives high corrosion-resistance and high strength in a single metal.

With pure Nickel; in bubble caps and trays; reboiler and condenser tubes, pumps, and piping. Nickel keeps metal pick-up at a minimum in hard-to-maintain areas.

The correct application of Nickel and Nickel alloys in the production or handling of glycerine can do much to lower costs and improve the quality of the product. Inco's Corrosion Engineering Section will be glad to work with you in solving specific problems connected with purity or corrosion in your own plant. Just write:

THE INTERNATIONAL NICKEL CO., INC.
67 Wall Street **New York 5, N. Y.**

Inco Nickel Alloys

Monel® • "R"® Monel • "K"® Monel • "KR"® Monel
"S"® Monel • Inconel® • Inconel "X"®
Inconel "W"® • Incoloy® • Nimonic® Alloys
Nickel • Low Carbon Nickel • Duranickel®

DRY air guards close Quantometer tolerances at Alcoa . . .

Quantometer room at Alcoa's Davenport, Iowa plant. This electronic equipment provides rapid, precise analysis of metals. Accuracy is safeguarded by maintaining a constant relative humidity and temperature in the room.

DATA AVAILABLE — Write for *Because Moisture Isn't Pink*, a booklet that explains the operation and tells how others are using all types of Lectrodryers. Pittsburgh Lectrodryer Corporation, 303 32nd Street, Pittsburgh 30, Pennsylvania.

This quantometer determines the elements in an aluminum alloy in less than a minute. To preserve its accuracy, Alcoa protects the quantometer against variations in temperature and relative humidity. The atmosphere in the room remains fixed day and night at a temperature of 75° F and a relative humidity of 40%. This exact humidity is controlled by a Lectrodryer*.

Perhaps changes in the weather affect a process, equipment or research of yours. If so, a Lectrodryer will permit you to control relative humidity to as low as 10%. Even in large areas, Lectrodryers can maintain dewpoints lower than −100° F. You can DRY air, other gases, and organic liquids in volume to pressures as high as 6000 psi with these machines.

In England: Birlec, Limited, Tyburn Road, Erdington, Birmingham.
In France: Stein et Roubaix, 24 Rue Erlanger, Paris XVI.
In Belgium: S. A. Belge Stein et Roubaix, 320 Rue du Moulin, Bressoux-Liege.

LECTRODRYERS DRY WITH ACTIVATED ALUMINAS

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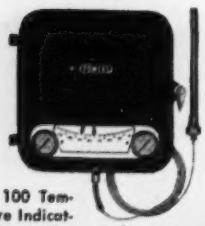
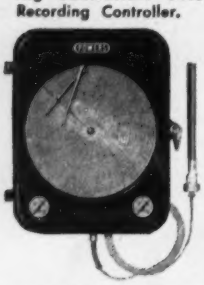
and Get Better QUALITY Products from Processes Requiring Precise Control of HEATING and COOLING

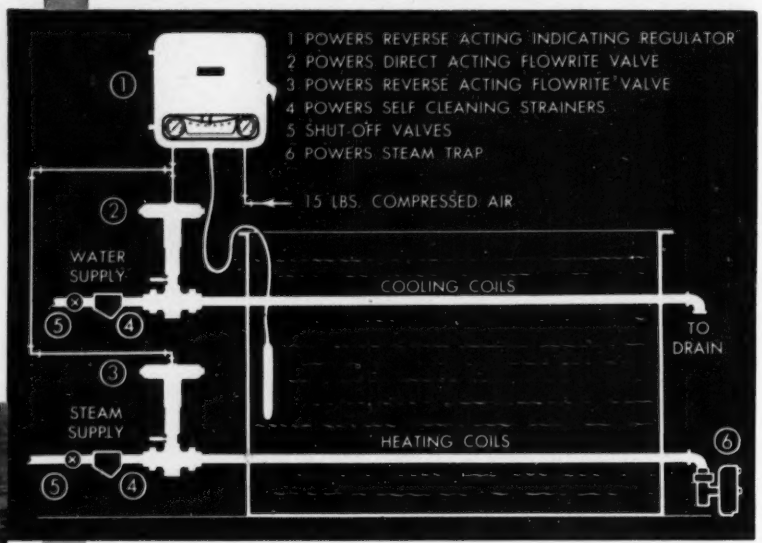


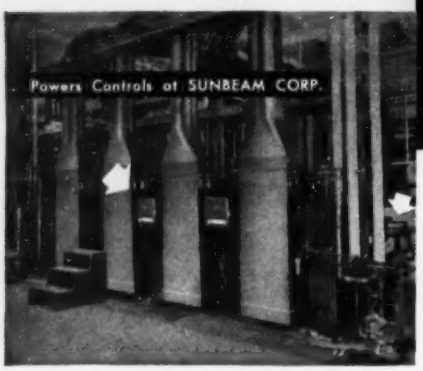
Series 100 Temperature Indicating Controller. Below: Recording Controller.



FLOWRITE Diaphragm Control Valve.

Powers V-Port Characterized FLOWRITE Valves are outstanding for their extremely accurate control and continuous trouble free operation.





install POWERS *Pneumatic* TEMPERATURE CONTROL

QUICK RESPONSE to Temperature Changes is obtained with POWERS control when applied to processes where a heating cycle is followed by a cooling cycle or vice versa.

In the example illustrated above chromium or nickel plating solutions are controlled. Either a Powers Series 100 Recording or Indicating Controller may be used. As temperature of the solution in the tank rises to set point of controller it gradually shuts off valve on steam supply. If temperature in tank rises above the set point, the controller quickly opens the valve on the cooling water supply which accurately maintains the solution at a uniform temperature.

Safety Feature: If compressed air supply to the controller should fail, steam valve is automatically closed and water valve is opened preventing any damage which might occur from over-heating.

Accurate temperature control will help your employees turn out more work and improve QUALITY. Preventing overheating saves steam and helps obtain the most effective use from solution under control.

Below: POWERS No. 11 Self-Operating Temperature Regulators. Standard type (left) is widely used for water heaters, metal parts washers and many other processes. Ask for Bul. 329. No. 11-MF (right) is simplest, most dependable regulator made for 85% of Metal Finishing Processes. Has durable plastic thermal bulb and tubing highly resistant to various solutions. Easy to read 4" dial thermometer indicates temperature of solution under control. Ask for Bulletin 330.

For **HEAT EXCHANGERS** and metal parts washers Powers **ACCRITEM** air operated Temperature Regulator is used with **FLOWRITE** Valve above. Ask for Bulletin 316.

Check your temperature control requirements with an experienced POWERS engineer. With a complete line of self operating and pneumatic operated controls he can help you select the right type of control for your requirements.

THE POWERS REGULATOR COMPANY

(b76)

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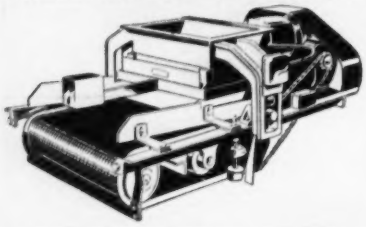
GRINDING MILL CONTROLS



CONSTANT-WEIGHT FEEDER
A regulating feeder which maintains a positive constant-weight feed rate regardless of feed size or volumetric variation. Bulletin 33-D-11.

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An electronic mill feed control which increases grinding mill capacity 8 to 20%. Bulletin 42-11.

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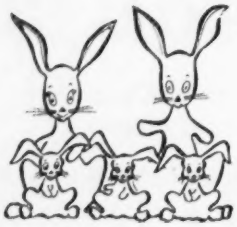

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THIS WHERE TO BUY SECTION supplements other advertising in this issue with these additional announcements of products and services essential to efficient and economical operation in the process industries.

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6—Atm. Double Drum Dryers, 22" x 38", 24" x 60", 42" x 120"
1—Feinc Rot. Vac. Filter, string disch., encl. housing, 4'6" dia. x 6', alum.
1—Oliver Precoat Rot. Vac. Filter, encl. housing, 5'3" x 3', rubber cov.
6—Stokes & Kux Pellet Presses
1—B-P #14 JEM Univ. Jktd. Mixer, Vac. Cov. 50 HP, 50 gal. work. cap.
2—W & P 100 gal. Sigma Blade Jktd. Mixer
1—Day 10 gal. St. St. Sigma Blade Jktd. Mixer
1—Pebble Mill 6'D x 8'L
20—Alum. Tanks—500 to 4000 gal.
30—Welded Steel Tanks—4300 to 15,000 gal.
30—Agitator Drives 3 HP to 40 HP.

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1 Baker-Perkins size 16 vac. jacketed mixer with explosion-proof motor Sigma Blades Type BB
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3 Colton #5½T tablet machines Reeves drive 5 HP motors
1 Shriver 36" filter press, iron, closed delivery, 32 chambers plate and frame
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1 Feinc 5' x 3' all monel vac. filter
1 500 gal. Baker Perkins unidor Jacketed Mixer
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1 Hersey 3' x 24' monel drier
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2 3000# steel jacketed ribbon blenders
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Bird Continuous Centrifuge; 18"x28"; Solid Conical Bowl
Freese Electric Ovens; in several sizes from Lab. up
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Stokes Rotary Jacketed Vacuum Dryer; 30"x10' with Condenser
315 Gal. Steel Jacketed Reactor with Paddle type Agitator; 44'x48"
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2 Enzinger Pressure Filters; 48"x62" with 15 Plates
Baker Perkins Type 316 S.S. Ter Meer Cont. Centrifugal; S 12
Readco 210 Gal. Jacketed Heavy Duty; Ribbon Mixers
Fitzpatrick Stainless Steel Model D Comminutating Machines
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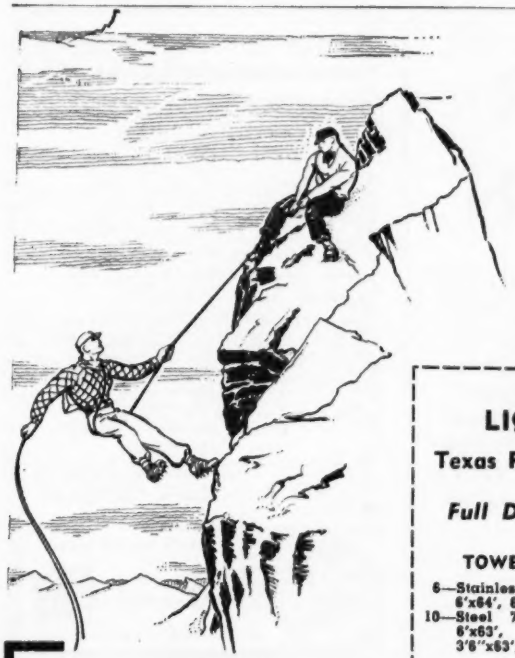

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10—Steel 7'x5'x70', 7'6"x55'6", 7'x42', 6'x63', 5'x61'6", 4'x110', 4'x72', 3'6"x63', 2'6"x60', 2'x75'.

Complete Oxygen Plant rated at 175 tons per day 95.5% pure oxygen.

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2—1440 sq. ft. 304 S.S. 75# PSIG, 340°F.
3—1345 sq. ft. steel, 70# PSIG, 300°F.
2—1125 sq. ft. steel, 850# PSIG, 900°F.
9—Kettle type reboilers, steel & SS, 1250, 1125, 750, 660, 400 & 340 sq. ft.
58—Atmospheric heat exchanger units, 304 S.S., 715, 477, 358 & 108 sq. ft.

OTHER ITEMS

1—Union Boiler 300 HP, 200# W.P.
2—Oliver 8'x10' Monel, Rot. Vac. Filters.
2—10,000 gal. steel welded Pressure Tanks 175# PSIG.
10—6'x30' ASME Horizontal Storage Tanks, 75# pressure.
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3—I.R. Propane Compressors steam driven 5410# per hr.
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DRYERS—KILNS

4—Reeves 7'x160', 7'x120' 5/8" shell.
1—Vulcan 8'x125', 3/4" shell.
2—Allis Chalmers 9'x80', 5/8" shell.
1—Link Belt 7'x45', 1/2" shell.
1—F. L. Smidth 4'x30', 3/8" shell.
1—Allis Chalmers 6'x35' Rotary Dryer.
1—Vulcan 4½'x50' Rotary Dryer.
5—Link Belt Hersey Rotary Dryers 3'x24', 3'10"x16', 7'5"x20'.
4—Louisville Steam Tube Dryers 6'x50', 6'x30', 5'x28'.
6—Devine Vacuum Shelf Dryers with 20, 17, 14, 9, 6, and 4 shelves.
1—Stokes 30"x8', 3'x15' Rotary Vacs.
4—Buflovak double drum 60'x144", 42"x90", 36"x84", 32"x52".
1—Devine 2'x4' Vacuum Drum Dryer 316 S.S.
2—Buflovak 6' dia. Crystallizers.
1—Buflovak 6'6" dia. Vac. Crystallizer S.S.

FILTERS

2—Oliver Monel 8'x10' Rotary-Vacs.
2—Eimco 8'v8', 4'x4' Rotary Vac.
8—Oliver Rotary Vacuum 11'6"x18', 11'6"x 14', 8'x12', 8'x10', 8'x8', 3'x6', 3'x1'.
2—Sweetland #12 with 72 and 36 leaves.
1—Niagara #110-20 with 12 S.S. leaves.
1—Sparkler #33-S-17 steel filter.
1—Shriver 36" P&F 42 chambers.
4—Shriver 30" P&F 30 chambers.
8—Sperry 24" P&F 16 chambers.
2—Sperry Aluminum 30" and 24" P&F.
1—Sperry 36" P&F 4 eye, heresite coated.
1—Swenson 4'x2' all nickel salting out Filter.
2—Sweetland #3 all stainless, 12 leaves.
12—Filter Press Skeletons, all sizes.

CENTRIFUGALS

1—Bird 48" Suspended Monel.
1—Bird 40" Suspended 347 S.S.
2—Bird 40" Suspended, rubber covered.
1—AT&M 36" center slung, rubber covered.
1—Fletcher 30" Suspended, steel.
1—Tolhurst 26" Suspended, steel.
2—Tolhurst 30" center slung, steel.
4—Bird 36"x72", 18"x28" continuous.
1—Sharples Nozljector DH-2, 304 S.S. 15 HP
2—Sharples C-27, C-20 Stainless Steel Super-D-Hydrators.
2—Sharples #16P Monel and SS Super Centrifuges.

PULVERIZERS—CRUSHERS

1—Devine 5'x10' steel, jacketed Ball Mill.
4—Abbe 6'x10' porcelain lined, jacketed, Pebble Mills.
2—Raymond 3 and 5 Roll High Side Mills.
4—Hardinge Mills 4½'x16", 5'x22", 5'x36", 6'x22", 10'x48".
6—Patterson 6'x8', 5'x6', 4'x5', 2½'x3½', brick-lined Pebble Mills.
5—Abbe 3'x4', 3'x3½' Pebble Mills.
2—Premier Colloid Mills 8" dia., S.S.
1—Jeffrey 30"x24" Hammer Mill, Type A.
3—Raymond, Gayco Separators 12', 8', 6'.
5—Mikro Pulverizers #2DH, #2TH, #1SH, #1SI and Bantam.

SCREENS

1—Day #81 single deck 40"x120".
1—Patterson single deck 40"x84" S.S.
1—#42 Rotex double deck 40'x84".
2—#12 Rotex double deck 20"x48".
1—#23 Rotex three deck 20"x80".
4—Tyler Hummer 4'x15', 4'x10', 4'x5' single deck with V-16 Vibrators.

MIXERS

4—Baker Perkins 300, 100, 50 and 1 gal. sigma blades, jacketed, steel and S.S.
1—Baker Perkins 50 gal. JEM, 50 HP.
1—Baker Perkins 35 gal. S.S. jacketed.
1—Robinson 4000# steel powder.
6—Rodgers 400 to 3000# powder.
4—Simpson Intensive Mixers #0.
8—New Portable Agitators ¼ 5 HP.
4—Day, Ross 8 and 50 gal. Pony.

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1—Pfaudler 500 gal. glass lined, jacketed, agitated Reactor.
2—Blaw Knox 800 gal. S.S. agitated Reactors 100# int. press.
6—Evaporators, single and multi-effect 300 to 14,000 sq. ft.
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4—Olivite, Duriron rubber and stainless steel Centrifugal Pumps 1" to 6".

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- Double Ribbon Mixer 2000#, 15 HP gear motor
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- Sperry 30"x30" Filter, 30 rec. plates (6)
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- Raymond 6' Double Whizzer Separator, 7½ HP
- Diamond 2-Sigma Arm Mixers, 125 gal cap, jckt
- Baker-Perkins 20 cu ft double sigma Mixer
- Moore Ball Mills 4'x5', 4'x3', Ghd motors
- Buflovak 2 effect Vacuum Pan, 5'6"x12' copper
- Sweetland #12 Filters, 36 & 48 leaves, Hydr. clos
- Eimco 8'x8' Filter, rot. cont. pract new
- Oliver Precoat Filter, 8'x10' rot cont, Iron
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COLUMNS — Everdur, 60"x23', bubble cap, 24 plates, 50 caps per plate.

Copper, 36"x16'x11 ga., bubble cap, 21 plates, 20 caps per plate.

Copper, 62"x22'5"x11 ga., bubble cap, 39 plates, 84 caps/plate.

Steel, 26"x27'9"x3/8" packed, 200#.

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MAKE	SIZE	TYPE	Max. Press.	Max. CFM
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Roots-Conn.	22	NAS	3	19
Sutorbilt.	3L	Cal.	3	69
Sutorbilt.	4L	Cal.	3	132
Roots-Conn.	47	AF	3	124
Sutorbilt.	5L	Cal.	3	249
Roots-Conn.	59	AF	3	205
Roots-Conn.	615	AF	3	360
Roots-Conn.	717	AF	3	650
Sutorbilt.	14 x 36	XB	3	3070
Roots-Conn.	8 x 20	RCR	3.5	955
Sutorbilt.	18 x 42	XB	4	5320
Roots-Conn.	22 x 36	RCD	5	5500
Roots-Conn.	33	AF	5	38
Roots-Conn.	44	AF	5	98
Roots-Conn.	67	AF	5	164
Roots-Conn.	710	AF	5	350
Roots-Conn.	14 x 36	RCR	5	3580
Roots-Conn.	16 x 24	RCD	5	2515
Roots-Conn.	10 x 18	RCD	6	805
Sutorbilt.	3M	Cal.	6	31
Sutorbilt.	4M	Cal.	6	76
Sutorbilt.	5M	Cal.	6	115
Sutorbilt.	6M	Cal.	6	189
Roots-Conn.	10 x 12	RCS	7	614
Roots-Conn.	53	AF	7	70
Roots-Conn.	76	AF	7	200
Sutorbilt.	4H	Cal.	10	39
Sutorbilt.	5H	Cal.	10	66
Roots-Conn.	65	AF	10	115
Sutorbilt.	6H	Cal.	10	128
Sutorbilt.	8H	Cal.	10	272
Roots-Conn.	10 x 10	RCR	10	616
Roots-Conn.	10 x 7½	RCD	10	440
Roots-Conn.	18 x 14	RCDH	10	2100
Roots-Conn.	24 x 23	RCDH	10	8610
Roots-Conn.	32 x 32	RCDH	10	14950

TURBO BLOWERS

Stock No.	Make	Size	HP	Vol.	Press. -oz.
1227	General Blower	800¾	¾	180	8
1501	Spencer	Special	1	92	10
879	Sturtevant	2	1	215	10
1226	Fisher	F15	1	300	10
880	Buffalo	4OR	5	750	10
1497	Eclipse	2-1	1	150	10.5
1473	Buffalo	3RE	7½	800	12
1659	Buffalo	5E	2	300	12
1200	Spencer	0755	5	850	12
546	Mohr	505	5	875	12
1587	Mohr	501½	1½	170	14
1495	Eclipse	2-1½	1½	100	15
769	Spencer	1001	1	110	16
1556	General Blower	1610	10	1300	16
1201	Spencer	1007	7½	1000	16
1202	Spencer	1005	5	600	16
1203	Spencer	1005	5	600	16
361	N. American	1716E	7½	1100	16
1532	Buffalo	4RE	10	800	24
1569	Sturtevant	170-225	60	10100	13
1601	N. American	1716-A	1	90	16
1605	Spencer	1005	5	635	16
368	Eclipse Fuel	6819	10	1200	16
689	Spencer	1010-A	10	1500	16
1601	General Blower	1630	30	3600	16
	Spencer	1015	15	1850	16
	Spencer	1007	7½	1000	16
581	N. American	15G2	5	700	19
1494	Power Engineering	2010	10	1150	20
1031	Spencer	1215	15	1675	20
1529	Ingersoll Rand	PS377	150	15000	20
1530	Ingersoll Rand	PS377	85	10500	20
1513	Spencer	1230	30	3400	20
2410	Spencer	1510	10	950	24
2415	Spencer	1515-H	15	1425	24
1500	General Blower	2425-1	25	2500	24
3220	Spencer	2020	20	1300	32
6193	Allen Billmeyer	D-6	7½	275	48
1000	Spencer	Special	200	8200	48
478	Allen Billmeyer	DA8	15	225	96
244	Allen Billmeyer	ED5B5	30	410	96

CENTRIFUGAL FANS

MAKE	SIZE	TYPE	Wheel Diam.	Inlet
American	11	FH	65¾	73⅛
American	9	AHS	53¾	61
Gen. Blower	9	FC	54	57
Buffalo	9	LLD	55	56
American	7	HS	44	50⅛
Clarage	3¼	W	42¾	44
Bayley	8	I	40	41
New York	39	ME	39	43
New York	36	ME	36	39¾
American	500	HS	30	32
Clarage	2¼	W	29¾	30¾
Sturtevant	6	Des. 3	27	27⅛
Buffalo	4½	LL	26¼	28
American	2	Sirrocco	16½	12
Buffalo	2	LL	12	12¼

STEEL PLATE EXHAUSTERS

MAKE	SIZE	TYPE	Wheel Diam.	Inlet Diam
Sturtevant	100	Des. 3	72¼	38
Sturtevant	70	Des. 3	49¾	26
American	80	ELS	48¼	29¾
American	70	ELS	42¼	25¾
American	55	ELS	36¾	23
Sturtevant	50	Des. 3	36	19
New York	33	GI	33	21¼
Buffalo	45	MW	32	19¾
American	50	ELS	31	18½
Gen. Blower	45	MX	27	18¼
American	35	E	23	15
Sturtevant	30	Des. 2	18	11
American	3	VRV	13	7
American	3	V	12	7
Buffalo	4½	E	11	5
Gen. Blower	20	MX	12	7¼
Peerless	11	PW	11	6
Peerless	9	PW	9	5
Allington-Curtiss	70		56¼	34
Buffalo	2	EH	6	3

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1—Day Mixer, steam jacketed, 50 gal. Sigma Blade.
1—Robbins Vibrex 3x6 Vibrating Screen, single deck.
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40—New Pressure Cookers, 15"x18" & 24"x28".
1—Buflovak Drum Dryer 5'x12'.
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1—Buflovak Jacketed Impregnating Tank 42"x52".
1—4x8 Sturtevant Jaw Crusher.
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2—Nash Air Compressors, Type AL-623.
1—Manton Gaulin Stainless Homogenizer, 125 gph.
1—Shriver 18" Aluminum Filter 9-plates 9-frames.
1—Rotary Dryer direct fired 54"x30'6".
1—Kennedy-Van Saun Rotary Dryer, 4'x40'.
Davenport Rotary Steam Tube Dryer, 6'x36'.
1—Gruendler Hammer Mill, 10 H. P.—new.
2—Ransome Rotating Drum Mixers 9' dia. x 11'x6".
1—#316 stainless Reactor, 265 gals. cap. jacketed.
Abbe Pebble & Tube Mill, 5'x22'—Burr-Stone Lined.
1—Patterson Ball Mill, porcelain lined, 17"x22".
1—Patterson Ball Mill 42"x36" jacketed.
3—Dopp Kettles with agitators, 600 gal. cap.
1—Sparkler S.S. Filter 18-D-6.
2—Large Steam Jacketed Horizontal Mixers.
Robinson Pulverizer #20, with 2 motors 10 HP each.
Robinson Ribbon Type Mixer, 30"x10'—like new.
6—Steam Jacketed Blackburn-Smith Filters.
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1—Abbe 140 gal. Pebble Mill, burr-stone lined.

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1—Buflovak Type 347 Stainless Steel Rotary Vacuum Dyrer, 5' x 20'.
2—Buflovak Double Drum Dryers, 24" x 36".
1—Buflovak Double Drum Stainless Steel Laboratory Dryer, 6" x 9".
1—Link Belt Steel Rotc Louvre Dryers, 7½' x 20'.
1—Stokes Rotary Vacuum Dryer, 3' x 12'.
1—Vulcan Rotary Kiln, 7' x 120'.
1—Buflovak Double Drum Dryer, 32" x 90".
1—Louisville Steam Tube Dryer, 6' x 50'.
1—Buflovak Double Door Vacuum Shelf Dryer, 20 shelves each.
1—Louisville Experimental Laboratory Dryer, 12" x 7½'.
1—Buflovak 24" x 24" Double Drum Dryer, Chrom. plated.
1—Devine #A Laboratory Vacuum Shelf Dryer with 3 Stainless Steel shelves.
2—Devine Single Door Vacuum Shelf Dryers, 10 shelves each.
1—Devine Single Door Vacuum Shelf Dryer, 5 shelves.

FILTERS

2—Shriver 24" x 24" Cast Iron Plate and Frame Filter Press, 22 chambers each.
1—Sweetland #2 Stainless Steel Filter.
1—Sparkler Type 316 Stainless Steel Filter Model 33 D 7.
1—Bird Young Filter, 4' x 2'.
2—Bird Type 316 Stainless Steel Filters, 18" x 24".
1—Shriver 42" x 42" C.I., P.F. Filter Press, 60 chamber, open delivery, with hydraulic closing.
1—Sperry Aluminum Plate & Frame Filter Press, 42" x 42", Closed Delivery, 3" Frames, 35 Chambers.
1—Sperry 42" C I Plate and Frame Filter Press, 16 Chambers, Closed Delivery.

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1—DeLaval Type 316 Stainless Steel Multi-Matic Centrifuge.
1—Fletcher Stainless Steel Suspended Type Centrifuge, 40" Perforated Basket.
2—A. T. & M. Stainless Steel Susp. Centrifuges, 48" Imperforated Baskets.
1—Sharples Type 316 S.S. Super-D-Hydrator, Model No. C-20.

MIXERS

1—Patterson Stainless Steel Double Arm sigma blade Mixer, 2½ gal.
4—Baker-Perkins Double Arm Jacketed Sigma Blade Mixers, 100 gal. capacity.
1—Gemco Double Cone 8' Blender.
1—J. H. Day Stainless Steel Double Arm Jacketed Sigma Blades Mixer, 150 gal. capacity.
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- 1—Tolhurst Suspended Type Centrifuge with 40" Stainless Steel Perforated Basket, complete with plow and motor.
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- 7—Buflovak Single Door Vacuum Shelf Dryers, 20 shelves each.
- 1—Devine Double Door Vacuum Shelf Dryer, 13 Shelves.

1—Mikro #3W Pulverizer.
1—Abbe #2 Buhrstone lined Pebble Mill, 5' x 4'.
1—Gruendler #24-40 Hammer Mill.

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1—Stainless Steel Jacketed Kettle, 100 gal. capacity, with Anchor Type agitator and drive, 125# jacket pressure.
2—Koven 13 gal. Stainless Steel Jacketed Kettles.
1—Patterson Stainless Steel Vacuum Reactor, 50 gal.
1—1600 gal. Type 347 Stainless Steel Storage Tank.
1—Type 316 Stainless Steel Storage Tank with coil, 3,000 gal.
1—Stainless Steel Jacketed Kettle, 2,000 gal. capacity.
1—Vertical Storage Tank, 10,000 gal. capacity, 125 psi.
2—Haveg Storage Tanks, 2,000 gallons each.
1—Combustion Engineering Stainless Steel Jacketed Autoclave, 500 Gals, 300 PSI.
1—Struthers Wells Steel Jacketed Vacuum Reactor, 1800 Gals. Cap. with Drive, Turbine Agitator & Coils.
12—Koven Stainless Steel Jacketed Vacuum Kettles, 380 Gals. Cap. Each.
1—Monel Storage Tank, 1,300 Gals.
2—Blaw Knox Steel Jacketed Autoclaves, 300 & 500 Gals. P.S.I. Working Pressure 500 lbs.
1—Patterson Steel Jacketed Autoclave, 900 Gals. Cap. Internal Pressure 120 lbs.
25—Steel Storage Tanks, 9,000-17,500 Gals.

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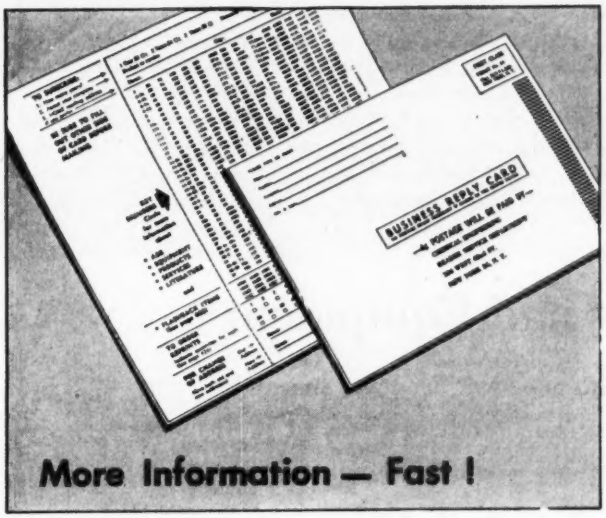

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Acid
- Barbituric 444A
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Well, Doc, how long will I live?

The service life of your stainless steel processing equipment is determined by your fabricator. In the professional skill of his mechanics, welders and craftsmen lies the answer to the useful life of that equipment.

For stainless fabrication requires a specialist — with manpower trained, experienced and equipped for that work. A general practitioner might miss up on something that would impair the strength or corrosion resistance of stainless steel. The special technique required for sound welds — the right degree of heat in welding a seam, the proper finish for your application — round corner construction to allow removal of corrosive materials — these often determine how long your equipment will "live" in service.

Years of working with stainless steel have shown us that many hidden weaknesses in the finished vessel can be avoided by proper methods of fabrication. For your next stainless steel vessel, consult with us.

S. BLICKMAN, INC.
609 GREGORY AVENUE
WEEHAWKEN, NEW JERSEY

S. BLICKMAN, INC.
Guards Alloys in Fabrication

SEND FOR THIS VALUABLE BOOK
A request on your letterhead will bring our guide, "What to Look For When You Specify Stainless Steel for Your Processing Equipment."

CORROSION RESISTANT PROCESSING EQUIPMENT

TANKS • KETTLES • STILLS • HEAT EXCHANGERS • AGITATORS • MIXERS • TOWERS • PIPING

Better DUST CONTROL ENGINEERING IS IMPORTANT!

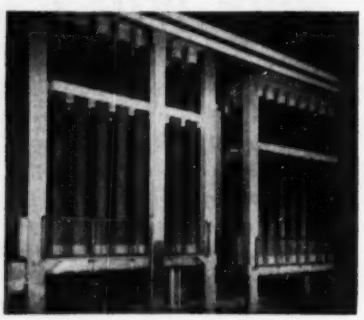
DAY *engineered* dust control includes plant survey, system layout, strategic location of equipment and efficient installation. These factors and many more are included in DAY'S *engineered* dust control to assure you the utmost in effectiveness and over-all economy.

DAY *engineered* dust control is backed by a program of constant research for greater equipment and system efficiency. For example, DAY engineers achieved an important advancement in dust filter efficiency with the development of DAY'S patented SELF-ADJUSTING BLOW RINGS for the DAY "AC" (Hersey Type) Dust Filter. These blow rings compensate for any variation in filter tubes due to changes in temperature, pressure, moisture conditions, etc. *They assure perfect cleaning air contact.*

Photo shows two of eight DAY "AC" Dust Filters used by Chas. Pfizer & Co., Inc. The filters shown are located at the Groton, Conn. plant. DAY'S Reverse Jet Cleaning permits the use of a better grade of pressed wool felt which captures even submicron dust particles.

5 Important DAY Advantages

1. DAY'S continuous Reverse Jet Cleaning permits the use of more efficient filter media which gives filtering efficiencies up to 99.99+%.
2. Constant air volumes are maintained.
3. Continuous, automatic operation without the necessity of shutting down any section for cleaning.
4. Air-to-cloth ratios to as high as 20 to 1.
5. Self-Adjusting Blow Rings assure perfect reverse air to cloth contact.



Two of the eleven DAY "AC" Dust Filters used by Pillsbury Mills, Inc. The filters shown are in the cake mix plant at Hamilton, Ohio. Space and headroom were at a premium in this modern, one story plant and the dust control equipment was placed to consume a minimum amount of space. Leading millers and food processors recommend DAY for dust control engineering.

Write For New Bulletin

If you have a dust control problem, whether it involves a complete system or a single unit, your inquiry is invited. WRITE FOR BULLETIN 528-R.

The DAY Company

856 Third Ave. N. E., Minneapolis 13, Minn.

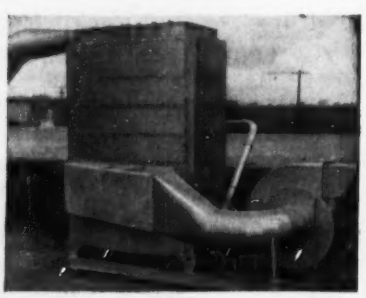
IN CANADA: P. O. Box 70N, Ft. William, Ontario

Branch Plants: Buffalo, Fort Worth, Toronto, Ontario

Representatives in Principal Cities

DAY SINCE 1881 DUST CONTROL

A SINGLE UNIT OR A COMPLETE SYSTEM



DAY "AC" Dust Filter installation, Lapp Insulator Company, LeRoy, New York. The company reports—"most of our dust is very fine and varies in size from 1 micron to 25 microns. The DAY Dust Filter solved our dust problem". DAY "AC" Filters consistently provide filtering efficiencies up to 99.99+%.

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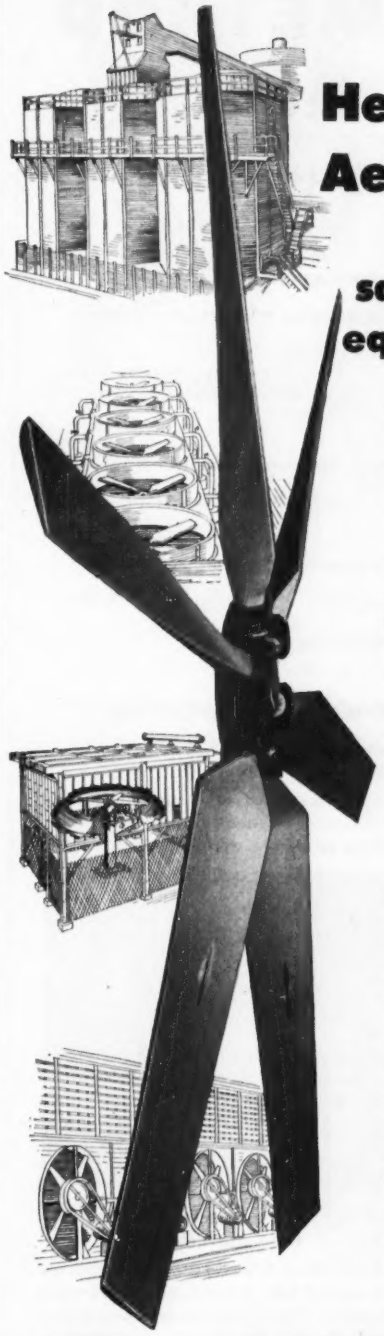


Here's Why Aeromaster Fans

mean more satisfactory cooling equipment operation

Manufacturers and users of cooling equipment agree... Aeromaster Fans give outstanding service. Here are the reasons why.

Aeromaster Fans are *precision engineered,* adapted from high speed aircraft propellers. They have adjustable blade pitch and anti-flutter design . . . therefore, require less horsepower. And they last longer too, thanks to the exclusive Aeroloid blade coating to resist acids and alkalies, abrasion and weather. Overall result: Aeromaster Fans *give more cooling at lower cost.*

Available in 4, 6, or 8 blade styles, in diameters of 5 to 24 ft., with capacities up to 1,000,000 cubic feet per minute, all Aeromaster Fans are fully guaranteed.

Koppers also has trained engineering specialists available in principal cities, insuring prompt, expert Aeromaster Fan service. And Koppers is always ready to consult with you on special fan problems. Next time you plan a replacement of present fans, specify Aeromaster. And when you consider new equipment, call on Koppers . . . always eager to be of service.

KOPPERS

METAL PRODUCTS DIV. • KOPPERS COMPANY, INC. • BALTIMORE, MD. • This Koppers Division also supplies industry with Fast's Couplings, American Hammered Industrial Piston and Sealing Rings, Koppers Electrostatic Precipitators and Gas Apparatus. *Engineered Products Sold with Service*

Aeromaster Fans

MAIL COUPON TODAY FOR COMPLETE INFORMATION

KOPPERS COMPANY, INC., *Aeromaster Fans,* 329 Scott St., Baltimore 3, Md.
Gentlemen: Please send me detailed information on Aeromaster Fans for

_____
(name and type of equipment to be cooled)

Name _____

Title _____ Company _____

Address _____

City _____ Zone _____ State _____

This NEW METHOD DRIES AIR

PRECISELY as you want it

- to control your product's quality
- to prevent condensation on your product or material
- to prevent changes due to moist air in contact with your product
- to protect your material from dampness
- to protect your processing of moisture-sensitive material
- to DRY your material or product
- to pack or store your product safe from moisture damage
- to get exact moisture control for the precise atmosphere condition you need
- to provide precise atmospheric conditions for testing
- to increase your air conditioning capacity
- to DRY large quantities of fresh air from outdoors

The Niagara's Controlled Humidity Method using HYGROL moisture-absorbent liquid is

Best and most effective because . . . it removes moisture as a separate function from cooling or heating and so gives a precise result constantly and always. Niagara machines using liquid contact means of drying air have given over 20 years of service.

Most reliable because . . . the absorbent is continuously reconcentrated automatically. No moisture-sensitive instruments are required to control your conditions.

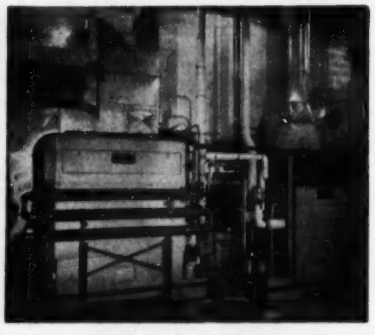
Most flexible because . . . you can obtain any condition at will and hold it as long as you wish in either continuous production, testing or storage.

Easiest to take care of because . . . the apparatus is simple, parts are accessible, controls are trustworthy.

Most compact, taking less space for installation.

Inexpensive to operate because . . . no re-heat is needed to obtain the relative humidity you wish in normal temperature ranges and frequently no refrigeration is used to remove moisture.

The cleanest because . . . no solids, salts or solutions of solids are used and there are no corrosive or reactive substances.



Niagara Controlled Humidity Air Conditioning

This method removes moisture from air by contact with a liquid in a small spray chamber. The liquid spray contact temperature and the absorbent concentration, factors that are easily and positively controlled, determine exactly the amount of moisture remaining in the leaving air. Heating or cooling is done as a separate function.

For complete information write

NIAGARA BLOWER COMPANY

Dept. CE, 405 Lexington Ave., New York 17, N. Y.

District Engineers in Principal Cities of United States and Canada

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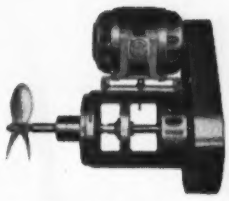
With NETTCO: THE JOB DICTATES THE DRIVE!

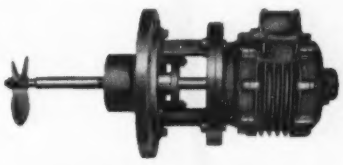
KBA Side Drive with Standard Belt Drive.

Nettco Agitation Engineers can help you get the right side drive agitator for your particular process. The Nettco line of side drive agitators offers a wide range of sizes, motor mounts, speed reduction designs, and stuffing box modifications. Standard units are available in the full range of horsepowers from ⅓ to 30. Frames, shafts, and propellers can be supplied in alloys to meet process conditions. **For detailed information on side drives ask for Bulletin No. 532.**

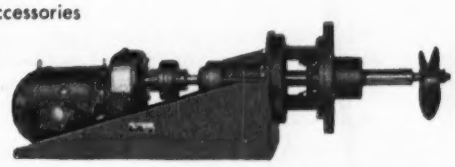


KBA Side Drive with Special Motor Mount.

Let Nettco help solve your agitating problems — with side drive or top entering agitators, with Nettco Flomix® pipe line agitators, with agitator fittings and accessories of all types. We'll be glad to quote on your requirements. New England Tank & Tower Co., 87 Tileston Street, Everett 49, Mass.



KMA Direct Motor Driven Side Drive.



KBA Gearmotor Driven Side Drive.

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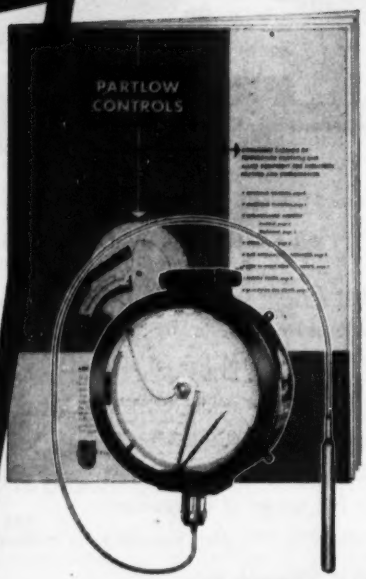
ENGINEERED AGITATION

FOR FIVE, CLEAR-CUT REASONS IT PAYS TO KNOW PARTLOW



Take RECORDING CONTROLS, for instance

SEND NOW for new condensed Catalog CC. See the seven different Partlow Mercury-actuated Recording Controls — designed to give you automatic process control, continuous temperature indication, permanent records, limit arrangements and hazardous location applications. Select controls tailor-made for your equipment — gas, oil, steam, water or electric. Available with electric or spring-driven chart drives — 24-hr., 48-hr., 7-day or any given cycle . . . 10 temperature ranges from −30° F to 1200° F.

All give you these important Partlow advantages:

1. **DIRECT-ACTING** hermetically sealed Mercury Bulb instrumentation. Positive, precise, sensitive — never temperamental.
2. **INTERCHANGEABLE ELEMENTS** — for quick, easy field replacement, without returning control to factory.
3. **ACCURATE CALIBRATION** — conservatively, within 1% of scale range.
4. **LONG LIFE** — thick-walled capillaries and seamless tubing assure almost indefinite life.
5. **LOW MAINTENANCE** — few moving parts — no need for compensators.

partlow

the pioneer in mercury thermal controls

Offices in All Principal Cities
THE PARTLOW CORP., NEW HARTFORD, N. Y.

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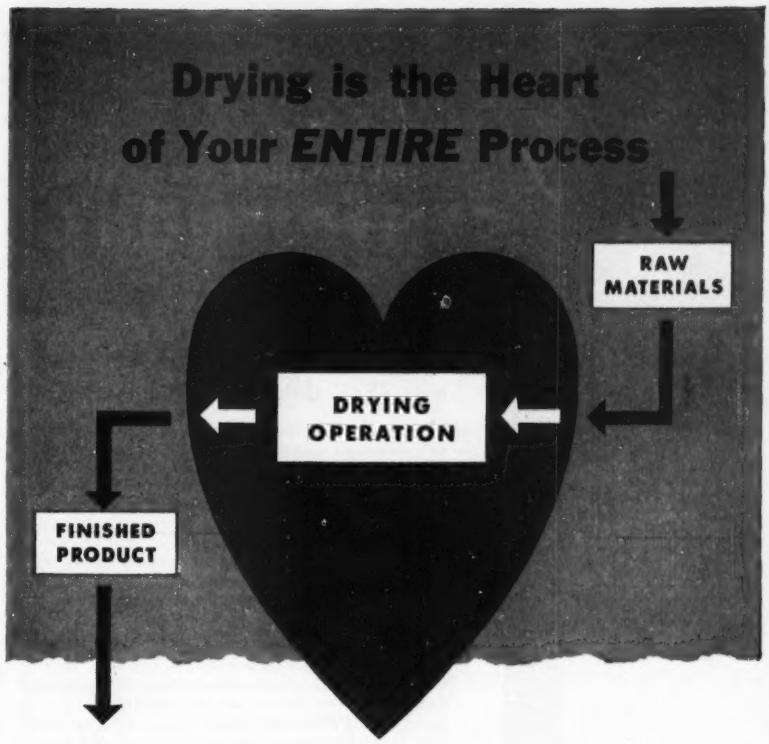

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Flashback

To make sure that you don't miss any news that could help you with your job, Chemical Engineering is doing a double take for you. The index below repeats the editorial listings only on chemicals, equipment and services featured last month in New Equipment and New Products. Use the postcard (p. 465) for more information on any item.

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First Report: "Air Centrifuge" installation at McLaughlin Gormley King Co.

Dear M[illegible]

I want you to know of the excellent results we are obtaining with the Superior Air Centrifuge which you installed for us some time ago.

Our problem was to recover an extremely fine vegetable dust (more than 90% passes through a 200 mesh screen) which was escaping our cyclone collectors, and was venting to the outside as a loss. Two cyclone collectors are used in connection with a pair of hammer mills which grind our product. Our over-all loss in grinding was from 2% to nearly 5%.

Our present installation uses a Superior Air Centrifuge in connection with a single hammer mill and cyclone and has resulted in the following benefits for us:

1. Cut former over-all loss in grinding by 50% or more.
2. Such complete recovery of the dust formerly vented to the outside that the air may now be discharged within the room with resultant heat saving in winter.
3. Increased operating efficiency so that the per mill output increased 50%.
4. Effected a desired particle separation by collecting the recovered fine dust separately.

Our experience with the Superior Air Centrifuge, as a means of helping to solve our dust problem and in reducing costs, has been very favorable, and I unhesitatingly recommend that anyone who has a dust problem contact your company for help in solving such a problem.

Yours very truly,

MC LAUGHLIN GORMLEY KING COMPANY
Dale C. LaCraft
Factory Manager

[illegible] pesticides are registered under the Federal Insecticide, Fungicide, and Rodenticide Act shall be identified in correspondence by the word (unregistered) or (reg. if the word is not a guarantee of registration. No discussion of unregistered products is intended as an offer for sale nor to endorse as such an offer. Such unregistered are only for the purpose of exploring the utility of these materials in the insecticide field. Only after an economic present is registered under the Federal Insecticide, laws or its agencies at firm prices authorized by the company.

"...I unhesitatingly recommend..."

THE ANSWER to your dust problem, too, may be the amazing new Superior Air Centrifuge. This new machine is earning praise throughout the industry for its unmatched performance on solids recovery and dust removal. Certainly, results such as Mr. LaCraft describes are well worth your further investigation.

CONTINUOUS REMOVAL of air or gas-borne solids is non-varying over an unusually wide variety of temperature and humidity conditions . . . temperatures up to 200 degrees higher than with machines employing standard filters. And the Air Centrifuge maintains maximum efficiency even in the very small particle-size ranges.

THE AIR CENTRIFUGE separates by a *patented, impelled-centrifuge principle.* And because it works without filters, screens, liquids or electro-static charges, it is adaptable to plant air flow systems wherever machines such as grinders, pulverizers, dryers, purifiers, solvent extractors, mixers, blenders, etc., are involved.

BEFORE YOU BUY any dust removal or particle recovery equipment, get the complete story on the Superior Air Centrifuge.

Call or write for further information.

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Your Guide to Technical Literature Now Available

What It Contains . . .

This is a comprehensive listing of the latest literature you can now get from manufacturers on chemicals, equipment and services in all fields of interest to chemical engineers. It lists new publications just issued as well as all bulletins mentioned in this issue. For your convenience, all items have been categorized and alphabetized.

For More Information . . .

You can get — and get fast — more information on any publication listed in this guide by using the Reader Service postcard inside the back cover. Simply circle the item's code number on the postcard, fill in your name and address, then mail to us. Ask for as many as you need. Answers come to you direct from the companies putting out the literature.

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Guide to Technical Literature

Want to build up your files and keep them up-to-date? This comprehensive guide to available literature will help you do just that. They're yours—free—for the asking.

Chemicals

Acid Anhydrous, Hydrofluoric.....40 p. book contains valuable information concerning hydrofluoric acid anhydrous. Provides useful data for those who now use HF, or for those who are contemplating its use.
96b Harshaw Chem. Co.

Acid, Barbituric.....Offers a Technical Data Bulletin containing properties and specifications, data on packaging and toxicity, as well as suggested applications and a resume of past experimental work. 8 p.
444A Kay-Fries Chem.

Acid, Formic.....Possesses a combination of properties which make it the preferred acid for numerous industrial applications. Supplies a Technical Bulletin covering data on volatility, solubility, purity, etc.
147 Heyden Chem. Corp.

Acid, Isocinchomeronic.....Valuable data on new heterocyclic dibasic acid. New Product Information Bulletin describes the physical and chemical properties, typical reactions, suggested uses, availability, etc.
444B E. I. du Pont de Nemours.

Acid, Phosphoric.....The chemical of a thousand uses. AA quality phosphoric acid, in its various grades, amply and consistently meets national formulary and pure food specifications. Data Sheet covers full details.
444C American Agricultural Chem.

Acid, Pyromellitic.....Presents a New Product Information Bulletin which covers details on suggested uses, physical and chemical properties, toxicity, availability, etc. Also includes a list of references.
444D E. I. du Pont de Nemours.

Alcohol, Tetrahydrofurfuryl.....As solvent its high boiling point coupled with complete miscibility with water makes it unique. Its solvency for resins, gums, dyes, etc., is excellent. Data in Bulletin No. 87.
444E Quaker Oats Co.

Aliphatic Derivatives.....16 p. Bulletin describes aliphatic derivatives (saturated hydrocarbons, olefins, chlorides, mercaptans, ethers, etc.). Also sodium derivatives and alkenyl succinic acid anhydrides.
444F Humphrey-Wilkinson.

Alkylphenols.....Octylphenol and nonylphenol useful in the manufacture of synthetic resins, fungicides, germicides, dyestuffs, and pharmaceuticals. Company makes available complete technical information.
444G Rohm & Haas Co.

Aluminas.....Used to improve products & reduce manufacturing costs. Enable refractories to withstand higher temperatures & last longer...improve dielectric strength of insulators...etc. Complete data.
55 Aluminum Co. of America.

Ammonia.....50 p. reference covers the technical aspects of handling, physical properties, and allied topics. Concerned with both anhydrous and aqua ammonia. Included are numerous drawings, charts, graphs, etc.
444H Spencer Chem. Co.

Ammonium Thiocyanate.....Specification Manual gives complete information on the properties and uses of ammonium thiocyanate, properties of aqueous solutions of ammonium thiocyanate, etc. Fully detailed.
444I J. T. Baker Chem. Co.

Boron Fluoride.....Its increasingly wide range of applications & cost-cutting production advantages—such as the ability to decrease sludge formation in many operations—make it a truly "all-round" catalyst.
149 Baker & Adamson.

Calcium Chloride.....60 p. Manual offers a complete & authoritative report on the newly developed high-test pellet-type calcium chloride. Full data on properties, specifications & applications included.
444J Dow Chem. Co.

Carbon, Activated.....Each grade engineered to application with a special combination of properties: the right size & shape, active surface area, adsorptive & catalytic capacity, etc. Data in Form 4712.
444K Carbide & Carbon Chem. Co.

Carriers, Catalyst.....Alundum carriers prove highly successful in reactions such as those involved in manufacture of phthalic anhydride, maleic anhydride and oxidation of ethylene. Full details in Bulletin No. 7.
266-7a Norton Co.

Chemicals.....64 p. Catalog offers technical information on many chemicals —trisodium phosphate (crystalline & monohydrate), chlorinated trisodium phosphate, disodium phosphate (anhydrous & crystalline), etc.
444L Blockson Chem. Co.

Chemicals.....Petrochemistry & biochemical operations form strong foundation for company's diversified output of several hundred important chemicals...for American industry. Details in Products Catalog.
444M Commercial Solvents Corp.

Chemicals.....New complete catalog offers valuable data on many chemicals: 3,4-Dihydroxyphenylglycine, 3,4-Dihydroxyphenylserine, 2,4-Dihydroxypyridine, 2,6-Dihydroxypyridine, Diiodolecithin, etc.
444N Bios Labs.

Chemicals, Aluminum.....Offers a growing family of superior quality aluminum chemicals. Includes information on calcined alumina, activated alumina, alumina trihydrate, aluminum dross, aluminum powders, etc.
90 Reynolds Metals Co.

Chloroform.....New additions to Solvay line—chloroform, carbon tetrachloride, methyl chloride, methylene chloride—feature the same consistent purity & dependability. Supplies samples & technical data.
444O Solvay Process Div.

Chlorpicrin.....Features a new booklet describing in detail why and how Larvacide (Chlorpicrin) has been used for thirty years in grain and warehouse fumigation to reduce losses from insects and rodents.
444P Larvacide Products.

Diisodecyl Adipate.....Announces a new Bulletin which describes the properties & performance of diisodecyl adipate, a low volatile, low temperature plasticizer for polyvinyl chloride resins. No. O-113.
444Q Monsanto Chem. Co

Emulsions.....Details on Neiradex No. 1 —an emulsion that is rinsed into Dynel industrial clothing during routine laundering to make the garments splash-resistant to acids and alkalies. Illustrated, 4 p.
444R Neirad Industries.

Emulsions, Asphalt.....Chemically inert asphalt emulsions are compatible hot or cold, wet or dry, with most resins, latices, fine fillers, fibers, aggregates, glues & other elastomers. Samples & details.
444S American Bitumuls & Asphalt.

Emulsions, Rubber, Chlorinated.....Water-thinnable emulsion of chlorinated rubber offers to the protective coatings industry a versatile vehicle for formulating a wide range of durable coatings. Bulletin 101.
445A Alfred Hague & Co.

Ethyl Acetate.....Two solvents, ethyl acetate and isopropyl acetate, are low-boiling or fast evaporating esters that have served the lacquer industry for many years. Details in reference, "Esters." No. F-4766.
445B Carbide & Carbon Chem. Co.

Ethylene bis (Glycolic Acid).....Of interest in preparation of polyamides, polyesters, plasticizers, synthetic lubricants, adhesives, etc. Complete property data included in New Product Information Bulletin.
445C E. I. du Pont de Nemours.

Flatting Agents & Pigment Extenders.....Covers general advantages of Celite diatomite products & gives valuable data on use of Celite in nine basic types of finishes—with one or more typical formulations for each.
445D Johns-Manville.

Glycols.....Strict production control assures consistent high quality. Complete Data Sheets provide valuable information on Mathieson glycols—ethylene glycol, diethylene glycol, triethylene glycol, etc.
445E Mathieson Chem. Corp.

Indulin.....Supplies detailed information on Indulin -70-GR-S, a coprecipitate of lignin and a butadiene-styrene copolymer. Covers data on processing and compounding product. Technical Bulletin No. 113A.
445F West Virginia Pulp & Paper.

Isopropanol.....To serve you as: an extractant—for white oils or petrolatum...to recover oils & pharmaceuticals from natural sources; a solvent—for ethyl cellulose & vinyl butyral resins; etc. Details.
445G Carbide & Carbon Chem. Co.

Lignosulfonates.....Polyfons are lignosulfonates with these properties: solubility in water, alkalies & acids; low surface tension in water; controlled extent of sulfonation; etc. Offers samples & Brochure.
445H West Virginia Pulp & Paper.

Lithium.....Valuable properties have achieved over-all savings—through shortcuts, reduction of waste, improvement of end product, simplification of operating procedures—in many industries. Data Sheets.
445I Lithium Corp. of America.

Maleic Anhydride.....Potential applications for maleic anhydride, such as synthetic resins, agricultural chemicals, coating resins, surface-active agents, etc., are outlined in a new Technical Data Sheet.
445J American Cyanamid Co.

Maleic Anhydride.....Produced in an improved tablet form that resists degradation in handling and minimizes fines. In quality, uniformity and form, new production sets an industry standard of excellence.
445K National Aniline Div.

Methoxy Polyethylene Glycols.....A new Technical Bulletin covers Carbowax methoxy polyethylene glycols. Reference includes information on physical properties, specifications, shipping, etc. No. F-6736.
445L Carbide & Carbon Chem. Co.

Methoxychlor.....Bulletin prepared for processors and manufacturers of aerosol sprays—provides up-to-date information on the use of methoxychlor in aerosol insecticide sprays and oil-based sprays. No. A-7582.
445M E. I. du Pont de Nemours.

Morpholine.....Issues a Technical Bulletin covering properties, specifications, shipping information, safe handling practices, suggested applications plus a selection of literature references. No. F-8488.
445N Carbide & Carbon Chem. Co.

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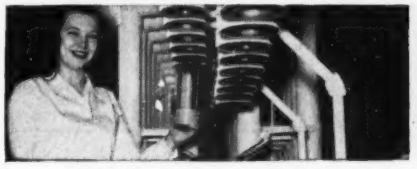

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Nitrocyclohexane.....An excellent solvent for wide variety of substances including waxes, resins, natural & synthetic elastomers & numerous organic chemicals. Details in New Product Information Bulletin.
446A E. I. du Pont de Nemours.

Nonyl Phenol.....Is a mixture of monoalkyl phenols, predominantly para substituted and is a clear viscous liquid. The side chains are isomeric branched alkyl radicals. Technical information and samples.
446B Jefferson Chem. Co.

Plasticizers.....Presents a 32 p. booklet which contains complete descriptions & specifications of the company line of monomeric & polymeric plasticizers. Includes physical properties & performance data.
446C Emery Industries.

Plastisols, Vinyl.....Company presents an informative Technical Bulletin concerning fungus resistant vinyl plastisols. Bulletin reports the correlation of experimental work by many major vinyl producers.
446D Scientific Oil Compounding.

Resins, Ion Exchange.....New edition of Nalco Bulletin provides technical data on Nalcite SAR & Nalcite SBR anion exchangers...includes complete up-to-the-minute information on silica removal. Bulletin 57.
318 National Aluminate Corp.

Santocel.....An unusual application versatility, demonstrated by 20 proven fields of use for Santocel—a silica aerogel—is described in a new booklet. Includes basic technical data on various types of Santocel.
446E Monsanto Chem. Co.

Soda, Caustic.....Effectively standardize processing methods. Inspections and analyses safeguard uniformity of caustic. Offers Data Sheets and Bulletin 100 which describes Hooker products and services.
241 Hooker Electrochem. Co.

Sodium Acetylides.....Offer a tremendous potential in the field of industrial organic synthesis. Company makes available a new Fact Sheet which contains information on typical reactions, preparation & handling.
446F Ethyl Corp.

Surface Active Agents.....Successful use 100% active nonionic surface-active agents by formulators of mechnical-dishwashing compounds is due to a unique combination of desirable properties. Data Sheets.
446G Wyandotte Chem. Corp.

Wax, Synthetic.....Armowax is useful in any application requiring a high-melting (132° C—275° F) wax, that possesses good initial color and heat-color stability. Provides detailed information and samples.
446H Armour Chem. Div.

Zirconium.....66 p. booklet, "Facts About Zirconium," offers information concerning the history and production of zirconium. Covers data on mechanical, physical and chemical properties, fabrication, etc.
446I Carborundum Metals Co.

Centrifugals, Continuous.....Illustrated Bulletin describes application of continuous centrifugal filters, listing 75 materials on which they are successfully used, with specific examples of performance.
446J Bird Mach. Co.

Centrifuges, Nozzle.....Information covers the numerous advantages and performance of the Sharples DV-2—the nozzle centrifuge with positive, externally controlled solids discharge valves. Data in Bulletin 1243.
127 Sharples Corp.

Chasers.....Chasers (edgerunners, mixers, mullers, etc.) are extremely sturdy in design, and improvements over a period of years have resulted in a minimum of maintenance. Information in detailed Bulletin.
361 Vulcan Iron Wks.

Classifiers, Continuous Centrifugal Company makes available descriptive literature on continuous centrifugal classifiers—what they do, how they work, with examples and pictures of successful applications.
446K Bird Mach. Co.

Collectors, Multi-Wash.....For the efficient removal of air-borne contamination (dust, fumes, vapors, acid gases and odors) and recovery of product thru multiple washing action. Bulletins Nos. 551 & 610.
BL376 Claude B. Schneible Co.

Converters, Dry Ice.....Dry ice converters are A.S.M.E. code pressure vessels especially adapted to charging with full 50-pound cakes of solid CO_2. Feature no operating costs. Folder offers complete details.
L349 Dry Ice Converter Corp.

Crushers, Jaw.....Issues a descriptive Bulletin with data on line of jaw crushers built in many sizes & types for various requirements. Specifications & approximate capacities, hp & weights. Illustrated. No. 062.
446L Sturtevant Mill Co.

Crushers, Rotary.....Rotary fine crushers are unique in that they crush or granulate to fine even sizes without producing a large amount of "fines" or dust. Includes data on operation & specifications. Bulletin 063.
301 Sturtevant Mill Co.

Demineralizers.....Available in variety of mono- and multi-column models (flow rates from 10 to 10,000 gph). Equipped with regenerant tanks and necessary gages, flow meter, etc. Offers fully detailed Catalog.
R345 Penfield Mfg. Co.

Demineralizers.....Offers demineralizer designs to meet the most stringent requirements—2-bed, 3-bed, 4-bed or compact mixed bed units manually or automatically controlled. Data in Publication No. 5800 Handbook.
315 Cochrane Corp.

Demineralizers, Water, Pressure Bantam.....Deliver demineralized water under pressure so that it can be piped to any desired point where mineral-free water is actually used. Details in new Bulletin No. 128.
446M Barnstead Still & Sterilizer.

Dryers.....Deliver top production, exacting performance, greater profits. Designed and constructed for hundreds of products and installed in countries throughout the world. Data in 12 p. illustrated Bulletin.
288 Standard Steel Corp.

Dryers, Adsorptive.....Help solve problems of drying air or other gases. Feature simplicity of operation and maintenance, low installation cost, and minimum maintenance expense. Details in Bulletin No. D-29.
141 C. M. Kemp Mfg. Co.

Drying Systems, Flash.....Handle materials in which drying is combined with pulverizing, or with mild disintegration, or followed by cooling and conveying the product to storage. Details in Catalog 54A.
312 Raymond Div.

Dust Collectors.....Reverse-jet dust collector provides many features: cleans as it filters—without interruption to operations; maintains filter porosity; prolongs filter life; etc. Data in 12 p. descriptive booklet.
102 Western Precipitation Corp.

Dust Control.....Company line of dust control equipment performs the vital service of product recovery and dust control in the numerous material processing operations. Offers complete descriptive literature.
328 Ducon Co.

Dust Control.....Covers special equipment engineered to solve individual problems posed by dusts of all kinds, fly ash, chemical fumes, gases of any temperature, aerosols, etc. Industrial Equipment Catalog A-654.
383a R. C. Mahon Co.

Dust Control.....Dust control equipment solves the problem of collecting valuable dusts—or controlling harmful dusts. Company makes available complete technical information in their 40 p. Bulletin No. 800.
76 Dracco Corp.

Dust Control.....Describes most direct method for determining the scope of your dust problem & your dust control equipment needs in new manual, "A Simplified Test Method for Dust Control Determination."
403 Dustex Corp.

Ejectors, Steam Jet.....Company's line of steam jet ejectors are available in single or multi-stage, with condensers as required. Provides details on advantages and performance in informative Bulletins.
297 Elliott Co.

Exhausts, Catalytic.....Describes catalytic exhausts for removing harmful exhaust fumes from internal combustion engines in both industrial and commercial equipment. Details in a new, illustrated, 4 p. Folder.
446N Oxy-Catalyst.

Filters, Pressure Leaf.....Supplies valuable literature outlining the design and construction advantages of new pressure filter. Also provides a table of filter sizes and capacities covering sixty-six models.
446O Bird Mach. Co.

Filters, Pressure Leaf.....For flow rates two to five times greater than cloth covered presses; positive removal of all suspended solids to desired degree of clarity; etc. Data in illustrated Catalog No. NC-1-53.
211 Niagara Filters Div.

Filters, String Discharge.....String Discharge handles almost any type of cake...thin, soupy slimes...heavy or coarse granular materials...or sticky gels. Contains complete data in illustrated Bulletin 103.
340 Filtration Engrs.

Generators, Acetylene.....Major advance in design...can generate acetylene continuously, even during carbide recharging & residue removal. Data on operation, features, specifications, etc. Fully illustrated.
446P Linde Air Products Co.

Process Equipment

Calculators, Centrifugal Force.....Company makes available upon request a handy centrifugal force calculator. This new, convenient, pocket-size slide rule provides the advantages of speed and accuracy.
310a Tolhurst Centrifugals.

Centrifugals.....Centrifugals with "all-speed" drive are used to determine best centrifuging speeds...can help to lower manufacturing costs & increase production. Illustrated Catalogs offer complete details.
310b Tolhurst Centrifugals.

Looking for something?

You can bank on spotting it—and fast—in our new, master Index to Chemicals & Equipment in this issue. You'll find it a complete, finger-tip reference to this month's advertised items and new product developments.

Kilns, Rotary.....Furnishes comprehensive 40 p. illustrated reference which offers valuable information on the company product line of rotary kilns, coolers, dryers, and slakers. Data in Bulletin No. 1115.
364a Traylor Engrg. & Mfg. Co.

Mills, Hammer.....Swing-sledge mills & hinged-hammer pulverizers built for reduction of soft, moderately hard & tough or fibrous substances to any degree of fineness ranging from 1 in. to 20 mesh. Bulletin No. 084.
447A Sturtevant Mill Co.

Mills, Hammer.....Williams heavy-duty hammer mills feature numerous valuable advantages: increase your output; improve product quality; reduce your cost-per-ton; etc. Find data in descriptive Catalog.
80a Williams Patent Crusher.

Mixers.....Homo-Mixer is built & operates on an entirely new principle. Draws only from the bottom of the tank with no vortex. Contains complete information on features & operation in Catalog No. 402.
TR398 Admiral Tool & Die Co.

Mixers.....Agitation specialists show how their services can help you attain the desired goal in process agitation—highest efficiency at lowest outlay cost. Covers mixer line in illustrated Catalog B-105.
123a Mixing Equipment Co.

Mixers.....Company makes available Confidential Mixing Data Sheet. Helpful checklist enables you to develop a complete technical description of agitation required for your process, quickly & easily. No. B-107.
123b Mixing Equipment Co.

Mixers.....For faster more thorough mixing. Describes the Hermas Jet mixer: theory of operation; interchangeable rotors; production capacities; applications; accessories; etc. Fully illustrated, 4 p. Folder.
447B Hermas Mach. Co.

Mixers, Dry-Batch.....Efficient rotating drum-type machines for mixing various substances together into a homogeneous and inseparable whole, every part of which presents the same analysis. Fully illustrated.
447C Sturtevant Mill Co.

Mixers, Laboratory.....Laboratory mixers: electric motor driven, direct drive, variable speed and geared models. Air motor driven models also available. Offers complete details in Bulletin DH-50.
123e Mixing Equipment Co.

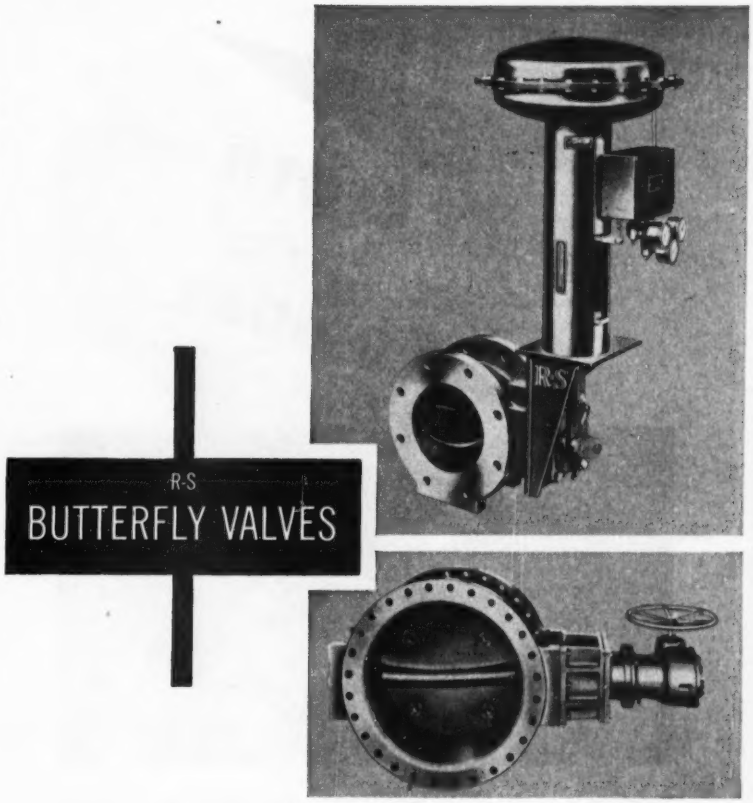
Mixers, Portable.....Use in industry reduces costs, saves time, labor and secures better and more refined products. Catalog includes data on construction, dimensions, specifications, etc. 28 p. No. B-108.
123e Mixing Equipment Co.

Mixers, Side Entering.....Furnishes detailed information on features, typical applications, mechanical design, maintenance, shaft seals, methods of installation, etc., in completely illustrated Catalog B-104.
123f Mixing Equipment Co.

Mixers, Top Entering.....Makes available pertinent information on top-entering mixers (propeller type)... for closed tanks, pressure and vacuum ...for open and loose-covered tanks. Data in Catalog B-103.
123g Mixing Equipment Co.

Mixers, Top Entering.....Illustrated and detailed 32 p. Catalog includes advantages, typical installations, mechanical description, construction information, dimensions and selection tables, etc. No. B-102.
123h Mixing Equipment Co.

Presses, Filter.....Presents new Catalog & Specification Book. Helps to improve your understanding of a vital process...aids in the selection of the proper equipment for your specific filtration needs.
49a D. R. Sperry & Co.



R-S VALVES ASSURE ACCURACY, SPEED AND ECONOMY

Automatic or manual—whichever you choose—the S. Morgan Smith R-S Valve line meets these three challenges to valve performance.

UNIFORM CONTROL IN ALL POSITIONS . . .
R-S Valves give consistent control of flow through all positions in its normal regulating range. The disc simulates a straight line, semi-log quality.

REGULATION AND CLOSURE ARE QUICK . . .
R-S manual valves are actuated by a lever, chain lever, handwheel or chain handwheel. Power actuation can be provided if desired.

MINIMUM PRESSURE DROP SAVES POWER . . .
The bevelled disc of the R-S Valve seats solidly with a metal-to-metal seat. Accurate machining and a 9° to 12½° angle of closing insure minimum clearance for minimum leakage. Drip-tight or bubble-tight closure can be obtained with the positive action of a rubber seat valve.

Over 75 years experience in hydraulic design and engineering stands behind valves. For further information about butterfly, cone or ball valves for use in the process fields, see your instrument maker or write to S. Morgan Smith Company, York, Pennsylvania.

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PUMPS
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CONTROLLABLE-PITCH SHIP PROPELLERS

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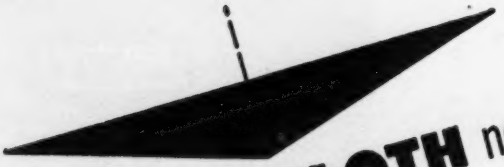

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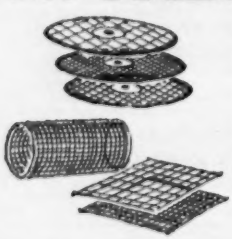

Filter leaves, strainers, sizing screens, etc. We can fabricate most any type of part you need, in any quantity. We'll work from your own prints or, if none are available, our Engineering Department will draw up prints from your description of what the part must do. Once you've O.K.'d them, we'll start production.

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LITERATURE . . .

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Reclaimer Systems, Oil.....A simple, economical and efficient method of restoring contaminated lubricating and sealing oil to the full value of new oil. Offers full details on reclaimers in descriptive Bulletin.
B347 Hilliard Corp.

Rolls, Crushing.....Built in numerous sizes and in three types: balanced rolls; plain balanced rolls; laboratory rolls. Offers detailed Bulletin covering description, uses, approximate roll capacities, etc.
448A Sturtevant Mill Co.

Scrubbers, Gas.....For removing tar vapor — lampblack — metallic fumes. Rotary multi-stage gas scrubbers have proven answer to low-volume requirements in metallurgical & processing industries. Bulletin AP-425.
86 Buffalo Forge Co.

Sifters.....By utilizing stacked decks, these space-saving units provide screening area equal to that of a single deck screen requiring four times the floor space. Other advantages in Bulletin No. 06B7625A.
253a Allis-Chalmers Mfg. Co.

Softeners, Water.....Provides valuable details on the Hydro-Softener. Includes a description of the unit, its operation, advantages, applications, sizes and capacities, etc., in illustrated Bulletin 4083.
448B Dorr Co.

Stills, Water.....Provides complete information & specifications on steam heated stills up to 250 gallons per hour; electrically heated type up to 10 gallons per hour; gas heated, up to 50 gallons per hour.
TL406 Consolidated Mach. Corp.

Strainers, Self-Cleaning.....For protection of process equipment, turbines, regulators, valves. Covers data on uses, strainer screens, specifications, dimensions, ordering, etc. in illustrated Bulletin 5308.
448C Leslie Co.

Pumps, Blowers, Compressors

Compressors.....Built for long life & constant performance. No internal wearing parts, no valves, pistons or vanes & no internal lubrication. Maintenance is low. Compact & save floor space. Offer Bulletins.
448D Nash Engrg. Co.

Compressors.....Are built to individual specifications and range from single stage to five and six stages with pressures up to 25,000 pounds. Assure efficient, trouble-free operation. Offers detailed Catalog.
332 Norwalk Co.

Compressors, Centrifugal.....Offers a complete line of centrifugals for gas compression and refrigeration—up to 10,000 horsepower in a single unit. Information in "Centrifugal Compressors for Industry."
448E Carrier Corp.

Compressors, Oil-Free.....For pressure-testing of food containers, oil-free ejection of metal stampings, paint spraying and general oil-free processing service. Contains complete details in Bulletin No. A-92.
74a Joy Mfg. Co.

Compressors, Reciprocating.....Capacity tables, specifications & information on operating features for compressors & condensing units with capacities ranging from 10 to 100 tons. Details in new Bulletin No. DS-361.
449A Trane Co.

Fans.....Aeromaster fans are precision engineered, adapted from high speed aircraft propellers. Have adjustable blade pitch & anti-flutter design... require less horsepower. Offers fully detailed information.
437 Koppers Co.

Fans.....American Blower fans are used extensively for forced and induced draft, ventilating, air conditioning, drying, fume removal, and processing systems. Offers literature on complete line of products.
58 American Blower Corp.

Fans, Exhaust.....Introduces a complete new line of corrosion-resisting exhaust fans. Offers pertinent data covering construction, dimensions, weights, and performance characteristics, in Bulletin No. F/1.
346 Duriron Co.

Pumps.....For automatically controlled delivery...pumps can handle any free-flowing liquid at discharge pressures from 300 to 15,000 psi & are available in 6 sizes—2"-6" stroke & 5-125 bhp. Data Sheet 65.
75a Aldrich Pump Co.

Pumps.....Covers Warren Cradle Mounted Compacunits. Includes basic design & construction features, sectional & external views, composite dimensions, material specifications, & other details. Bulletin 247.
449B Warren Steam Pump Co.

Pumps.....For long trouble-free life when handling severe corrosives. Offers Durco Catalog which briefly describes alloys and equipment, and lists detailed Bulletins covering specific items. Catalog 54.
233 Duriron Co.

Pumps.....Information on the number of rings, depth of box, type of packing...chemical and physical properties of fluid being pumped, speed of shaft, and other pertinent usable facts, in Bulletin S-147.
L352 Taber Pump Co.

Pumps.....Issues new Bulletin on series of pressure balanced oil hydraulic gear type pumps designed for heavy-duty machine tools, materials handling, earth moving & other mobile equipment. Illustrated. No. 142.
449C New York Air Brake Co.

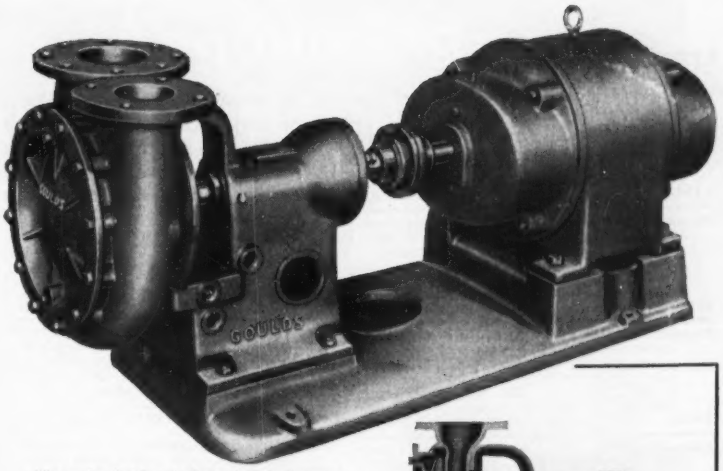
Pumps, Boiler Feed.....Used throughout industry for numerous services. Capacities range up to 2000 gpm, pressures to 1,200 psig, temperatures to 350F. Contains complete information in Catalog No. 1502.
275 De Laval Steam Turbine Co.

Pumps, Centrifugal.....For corrosive & non-corrosive liquids. The latest in pump engineering & design incorporated in company line for maximum efficiency & severe, continuous service. Offers complete data.
323 Industrial Filter & Pump.

Pumps, Constant Stroke.....For medium to high pressure service...make use of one of the numerous Aldrich constant stroke pumps—the direct flow Triplex or Multiplex pump. Details in Data Sheets 64, 64A & 64B.
75b Aldrich Pump Co.

Pumps, Double Suction.....Rugged double suction pumps assure long life and low maintenance. Feature heavy-duty construction, wide material choice, unit responsibility, etc. Offers details in Bulletin No. 08B6146.
305 Allis-Chalmers Mfg. Co.

Pumps, Dredge.....Offer most-wanted features in a dredge pump. Include lowest cost per ton moved, durability, reliability, simplicity, minimum hp, easy maintenance, good vacuum performance, etc. Bulletin 184.
449D Morris Mach. Wks.



The entire fluid end of this chemical pump is available in any of the following metals: 316, Gould-A-Loy 20, 304, all iron, all bronze or bronze fitted, all iron with stainless trim. Nine sizes ranging from ¾" to 3"; capacities up to 720 GPM; heads to 200 ft.

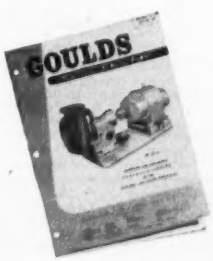
You get a lot for your money

in this new chemical pump

New design features of the Goulds Fig. 3715 centrifugal pump offer you special operating and maintenance advantages in handling acids, alkaline liquors, and slurries.

The liquid end of the Fig. 3715 is the same as in its immediate ancestor, the Fig. 3705. Thousands of severe-service applications have shown us no way to improve it. But the support head is completely new. It's a sturdy, box-type design with water cooling which raises the maximum liquid temperature limitation to 350° F. It has grease-lubricated standard bearings with grease relief that helps prevent over-lubrication . . . and a simple, positive external arrangement for adjusting impeller clearance without any dismantling.

With the stuffing box under suction pressure only, you will have infrequent need for re-packing and a new freedom from excessive leakage. You can inspect and clean the interior, and you can remove or replace the impeller, without disturbing suction and discharge connections.



Bulletin 725.4 describes *all* the operating and maintenance advantages of the Goulds Fig. 3715 chemical pump. It defines the extensive standardization this design accomplishes for simplifying your parts inventory. It gives you detailed performance curves. We will be glad to send you a copy. Just write for Bulletin 725.4.

MEMBER

Goulds PUMPS INC.
Seneca Falls New York

ATLANTA • BOSTON • CHICAGO • HOUSTON • NEW YORK • PHILADELPHIA PITTSBURGH • TULSA

Pumps, Gear.....Information on Hydrex —low cost gear pump for continuous heavy duty. Range: 32 ssu to 250,000 ssu...1-500 gpm...300 psi for continuous duty, 500 psi for intermittent service. Fully detailed.
L404a Sier-Bath Gear & Pump.

Pumps, Proportioning.....The economical, quick answer for chemical proportioning in process operations... these versatile pumps are complete, self-contained and ready to operate. Bulletins offer complete details.
107 Proportioneers, Inc.

Pumps, Rotary.....Presents detailed information on Gearex—for low cost pumping of non-lubricating liquids. Range: 32 ssu to 1,000,000 ssu . . . 1-550 gpm . . . 250 psi for viscous liquids, 50 psi for water.
L404b Sier-Bath Gear & Pump.

Pumps, Screw.....Provides valuable data on screw pumps...most dependable for non-lubricating liquids. Range: 32 ssu to 1,000,000 ssu...1-1000 gpm ...1000 psi for viscous liquids, 500 psi for water.
L404c Sier-Bath Gear & Pump.

Pumps, Vacuum.....In hundreds of major vacuum processing systems... pumps create low absolute pressures fast and efficiently, and provide quick recovery speed for high production rates. Data in Bulletin V54.
97 Kinney Mfg. Div.

Pumps, Vertical Turbine.....Offers data on line of multi-stage vertical turbine pumps. Describes and illustrates successful and exacting design, construction and performance characteristics. Bulletin B-1700.
299 Peerless Pump Div.

Ventilators.....Employed as a blower or as an exhauster, the two-way ventilating system is a compact, easily portable ventilator which features many applications in a variety of industries. Bulletin No. 1503-1.
450A Mine Safety Appliances Co.

Instruments & Controls

Cable.....With new material specially designed for pneumatic connecting lines you can make better instrument and control installations in less time and at less cost. Bulletin offers complete details.
78 Bailey Meter Co.

Comparators.....For quick, easy determination of pH, chlorine, phosphate or nitrate. Describes theory and application of pH and chlorine control and covers the line of comparators. Completely illustrated.
L398 W. A. Taylor & Co.

Control, Dew Point.....In successful use in nuclear fission, pharmaceutical, food and chemical plants, distilleries, photo film production, drying and storage operations. For full data request Bulletin No. 407.
139 Foxboro Co.

Control Stations.....New Mini-Line control station provides complete picture of control system performance and full flexibility of remote control. For complete details refer to Product Specification P99-1.
450B Bailey Meter Co.

Control Systems.....Cabinetrol panels form a standard low-voltage control system that handles all motor types up to 600 hp from central location. Offers complete information in illustrated Bulletin GEA-3856.
65 General Elec. Co.

Control Systems, Process.....All-encompassing advantages assure...highest reliability of instrument performance, minimum maintenance & utmost in flexibility. Find complete information in Catalog No. 164.
273 Manning, Maxwell & Moore.

➔ Want more information on any of these items? Just circle its code number on the postcard inside the back cover, then mail to us. It's that easy now.

Controllers.....Automatic recording pressure controllers for homogenizers & high pressure pumps. Offer advantages of increased processing efficiency, direct & immediate labor savings, etc. Bulletin RPC-54.
450C Manton-Gaulin Mfg. Co.

Controllers, Pneumatic.....Covers data on stack-type pneumatic controllers for process variables. Illustrated with cutaway construction photos, schematic diagrams and dimension drawings. 12 p. Catalog 53-10.
450D Fischer & Porter Co.

Controllers, Ratio.....Controllers regulate critical gas mixtures in carbon black production. Makes available detailed reference data—Catalog 2320, "Flow Meters, Indicating, Recording, Integrating and Controlling."
32-3a Minneapolis-Honeywell.

Controllers, Speed.....Covers detailed information on a time delay speed controller designed to fit all makes of electric trucks. Illustrated Bulletin describes the method of operation of the unit. No. 1599.
450E Yale & Towne Mfg. Co.

Controls, Valve.....LimiTorque is the latest and most advanced valve control for operation of small valves. Includes description, application, features, ordering information, etc. in illustrated Bulletin.
34 Phila. Gear Wks.

Indicators, Electrolytic Conductivity..... Describes use for measuring the purity of condensate and various other solutions, sugar ash, and the conductivity of soil and soil extracts. Data Sheet E-95 (1).
450F Leeds & Northrup Co.

Indicators, Electronic Level.....For accurate, continuous level measurement of liquids or divided solids. Feature savings in initial cost and in maintenance. Complete new instrument information available.
337a Fielden Instrument Div.

Indicators, Temperature.....Details on a sensitive, rapid-responding temperature indicating instrument. Specification data on accuracy, battery life, response time, cable length, etc., in illustrated Form 196.
450G Beckman & Whitley.

Instruments.....Presents valuable 64 p. Catalog featuring a complete listing of the company line of instruments and accessories. Also included are brief descriptions of the most widely used analytical systems.
450H Coleman Instruments.

Measuring Systems, Load.....Simplify operations and save time and money ...whatever your load, fluid pressure or torque measurement problem may be. Covers advantages and details in fully illustrated Bulletins.
101 Baldwin-Lima-Hamilton Corp.

Meters & Controls.....Company makes available information on their line of meters and controls for the process industries. Includes detailed equipment descriptions and illustrations in Bulletin No. 17-F.
450I Bailey Meter Co.

Meters, Flow.....Presents a new, illustrated Bulletin which includes the design features, maximum flow capacities, maintenance requirements, and mounting drawings of multiple stage flow meters. No. 1052.
450J Commercial Research Labs.

Photofluorometers.....New Photofluorometer is latest in the company line of fluorimetric instruments. Offers greatly increased sensitivity and improved stability. Find complete information in Bulletin B-230.
450K Coleman Instruments.

Proportioners.....Automatic proportioning units for use with chlorinators described and illustrated with flow diagram, cross-section drawing, installation drawing, and specifications, in Catalog No. 70-20.
450L Fischer & Porter Co.

Recorders, Operation.....New Bulletin describes and illustrates company's line of electrical and mechanical operation recorders, both round- & strip-chart models. Covers features & applications. No. OP1505.
450M Bristol Co.

Spectrometers, Mass.....Designed to continuously measure amount of various constituents in a process stream. Covers operation, features, performance characteristics, specifications, etc. Bulletin CEC-1824A.
251 Consolidated Engrg. Corp.

Spectrophotometers.....Outperform all commercial instruments with respect to resolving power, photometric accuracy, wavelength accuracy, freedom from stray light, etc. Offers details in Data File No. 93-17.
143 Beckman Instruments.

Switchboard & Panel Instruments..... Descriptive Bulletin presents complete details on a new line of 4½ in. switchboard and panel instruments with clear plastic fronts and "in-line" pointers and dials.
450N Weston Elecl. Instrument.

Telemetering.....Furnishes a fully detailed Bulletin describing the company line of Metameter telemeters and accessories. Reference is illustrated by almost 100 photographs and line drawings. No. M1710.
450O Bristol Co.

Templistik® Instruction.....Critically examines the factors which affect temperature indication by means of Templistiks®. Suggestions on how to determine temperatures in a number of special cases are described.
450P Tempil Corp.

Testing Machines, Concrete.....Describes a new 200,000 lb. capacity portable testing machine which makes possible rapid on-the-job testing of concrete and similar materials with laboratory accuracy. Full details.
450Q Soiltest, Inc.

Thermometers.....Sturdy all-metal construction resists breakage, makes for far longer life on operating equipment. Exclusive multiple helix assures dependable accuracy during long life. Detailed Bulletin.
296 Weston Elecl. Instrument.

Transmitters, Pneumatic.....Metagraphic transmitters set new standards of accuracy & reliability in measuring & transmitting readings of temperature, pressure, vacuum, differential pressure, etc. Bulletin A105.
66 Bristol Co.

Tubes, Dall Flow.....Technical Bulletin describes new short differential producing metering device. Covers recovery characteristics, accuracy, applications, range, flow formula, laying length, etc. No. 115-L3.
450R Builders-Providence.

Viscometers.....Standard instruments for nearly every type of viscosity determination problem. Feature high accuracy & sensitivity. Fully illustrated 1954 Catalog offers data on all models & accessories.
M390 Brookfield Engrg. Labs.

Viscosity Measuring Instruments..... Measure, record and control viscosity —instantly, automatically, continuously—with the Ultra-Viscoson. Covers data on features, operation, applications, etc. Illustrated.
450S Bendix Aviation Corp.

Watches, Stop.....Precision timers with coil spring shock absorbers. Offers new Catalog describing line of 60 different heavy-duty stop watches with varied applications in industry, research, and medicine. 12 p.
451A Arthur S. La Pine & Co.

Construction Materials

Coating Systems, Protective.....Modern approach to maintenance-painting halts corrosion. Sixteen specialized protective coating systems cover requirements of hundreds of strong corrosives. Bulletin MC-8.
56a United Chromium.

Coatings, Protective.....Covers uses & properties of Solaramic coatings—a family of proprietary ceramic coatings specially designed to protect high or low alloy steel fabrications from heat or corrosion. 8 p.
451B Solar Aircraft Co.

Coatings, Protective.....Presents comprehensive information on a complete line of corrosion-proof linings, bricks, bonding cements, protective coatings and mastic floors. Covers details in Catalog No. G-201.
451C Cellcote Co.

Coatings, Protective.....For any equipment or surface that can be uniformly baked...Plastisol compounds offer easy, economical way to apply long-lasting vinyl coating protection. Details in Bulletin No. VP-1.
56b United Chromium.

Electric Furnace Shapes.....Information on electric furnace refractories—cores, tubes, muffles—of Alundum or Crystolon materials. Tells how to construct electrical furnaces for laboratory. Bulletin No. 458.
266-7e Norton Co.

Fabrication, Metal ..... **Manufactures** metal products for numerous industrial uses...from complete carbon-black plants to steel conveyor boxes. Designs, engineers and fabricates to specific needs. Full details.
350 Boardman Co.

Jacketing, Aluminum.....Announces a new completely illustrated Folder containing full application instructions for Childers jacketing for weather-proofing of insulated lines, towers, vessels, and tanks. 4 p.
451D Childers Mfg. Co.

Linings, Drum.....Unichrome drum linings deliver resilient, seam-free pore-free protection against such materials as acids, alkalies, salt solutions, alcohols, detergents, etc. Descriptive Bulletin No. DL-2.
56c United Chromium.

Paints, Metallic Zinc.....Institute announces the availability of an informative, detailed booklet which contains complete facts on MZP—metallic zinc paint—for structural steel and galvanized surfaces.
324b American Zinc Institute.

Process Equipment, Fabrication.....Designed and built around the use of Haveg—basic construction material that resists corrosion. Size and chemical resistance charts in 64 p. illustrated Bulletin No. F-6.
293 Haveg Corp.

Refractories.....By lasting longer, refractories automatically cut costly downtime losses ... maintenance ... and labor. Use of heat more efficiently results in increased production, reduced fuel costs. Fully detailed.
85 Carborundum Co.

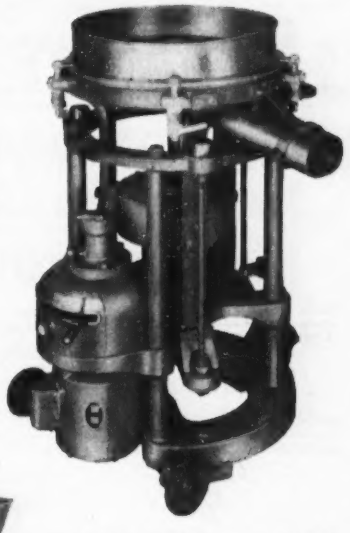
Refractories.....No other refractory is so chemically stable at such high temperatures under both oxidizing and reducing conditions. Includes fully detailed information on properties in Bulletin No. 1409.
266-7d Norton Co.

Announcing—
New Sieving and Straining Machines

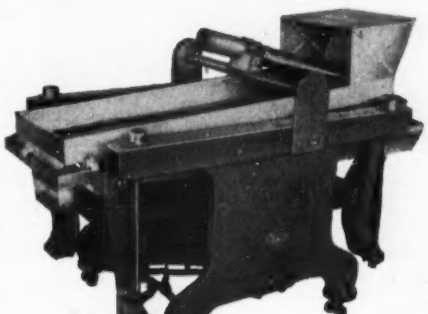
. . . substantially increased capacity
. . . wider adaptability . . . non-blinding!

Entirely new standards in sieving and straining are now practicable due to recent developments in the design of gyratory machines. Incorporating the unbalanced flywheel principle and capable of variable amplitudes and variable speeds up to 3500 cycles per minute, they make it possible to attain the critical setting for each material. This assures maximum throughput.

The peculiar sieving action sets up tiny vortices in the openings in the mesh. This permits handling materials heretofore considered unsievable. Also, it eliminates blinding or clogging of the mesh.



Variable speed sieving and straining machine. Permits attainment of critical speeds for optimum output.



Continuous separator for use with materials containing relatively large proportions of reject.

Another advantage, too, is the fact that this action puts relatively little wear and tear on the mesh and screens last much longer.

These machines occupy much less area than other similar equipment, are easy to clean and inexpensive to operate. Maintenance is at a minimum. They are recommended for the sieving and straining of flour, starch, syrups, chocolate, cocoa, coal tar, fatty oils, petroleum oils, pharmaceuticals, explosives, paints, varnishes, wood pulps, and many other materials.

Send us your problem and we will be glad to advise you.

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Sheets, Galvanized.....For industrial roofing & siding. Offer low initial, application, & per-year costs; the strength of steel; rust protection of zinc; etc. Descriptive booklet presents complete information.
324c American Zinc Institute.

Tin.....New, 20 p. booklet tells important story of Straits tin and its many uses today. Includes sections on new tin alloys, tin solders, tin chemicals. Covers tin resources and supply. Fully illustrated.
452A Malayan Tin Bureau.

Titanium.....Shows resistance to chloride solutions and retains useful strength up to 800-1000F. Other advantages and data on application and fabrication of titanium alloys in descriptive Rem-Cru Review.
287 Rem-Cru Titanium.

Pipe, Fittings, Valves

Fittings.....Offers Klinger Master Catalog describing the complete range of products...compressed asbestos sheet packings for all purposes, valves, cocks, level gages, synthetic and silicone rubbers.
129a Klinger Corp. of America.

Fittings, Pipe.....Offers detailed information on superior corrosion-resistant pipe fittings...screwed, flanged and butt weld. Includes the complete company product line in illustrated Catalog No. 653.
L396 Camco Products.

Fittings, Welding.....Company's line of welding fittings cast in all corrosion and heat resistant alloys...gives you freedom of design on piping systems. Descriptive booklets provide essential information.
339 Electric Steel Foundry Co.

Flanges.....First in flanges—company started first and has remained first ...in scope of flange types, sizes, weights, and materials...in volume produced. Presents valuable booklet, "Modern Flange Design."
73 Taylor Forge & Pipe Wks.

Hose & Ducts.....Industrial installations of Flexaust hose & Portovent duct for moving air, dust, fumes, gases, and materials efficiently and at lower cost are described in fully illustrated Bulletin 40.
452B Flexaust Co.

Hose, Metal, Flexible.....Provides valuable information on flexible metal hose...for Diesel engine installations —marine and industrial. Includes data on types of hose, installation, etc. Bulletin EH-50.
452C American Metal Hose Branch.

Joints & Couplings.....Teflon expansion joints and flexible couplings absorb shock, vibration, thermal expansion and contraction. Connect unlike piping ends and nozzles. Covers complete data in Bulletin FC-952.
333 U. S. Gasket Co.

Joints, Swing.....Covers information & detailed specifications on 35 styles of bronze & steel, plain & flanged swing joints. Recommendations & data on use, care & maintenance of equipment. 12 p. Catalog No. F-8.
452D OPW Corp.

Joints, Swivel.....Ball-bearing swivel joints are precision engineered...to give unlimited flexibility and unlimited service in the conduct of fluids, gases and liquids. Details in Industrial Catalog No. G-4.
84 Chiksan Co.

Nozzles, Spray.....Company provides a 48 p. industrial Catalog with full data on thousands of standard and special nozzles...for every type of spraying. Also includes information on related equipment.
349 Spraying Systems Co.

Pipe & Fittings, Glass.....Glass pipe & fittings for full-scale production operations. Strengthened by end-tempering & feature corrosion-resistance, non-contamination, etc. Details in Catalogs EA-1 & EA-3.
254-5a Corning Glass Wks.

Pipe, Fittings & Valves.....For those operations which require the conveying of corrosive liquids. Feature valuable advantages of easy installation, added safety, no leakage, etc. Catalog details company line.
344 Saran Lined Pipe Co.

Pipe Installation, Glass.....Pipe is easy to install and low in installed cost compared with other corrosion-resistant materials. Available in 6 standard sizes from 1- to 6-inch I.D., inclusive. Booklet No. PE-3.
254-5b Corning Glass Wks.

Piping.....A presentation of corrosion fundamentals of plumbing & heating systems. Data based on analysis of thousands of piping systems in which wrought iron is specified to help solve corrosion problems. 32 p.
453A A. M. Byers Co.

Tubing.....Flexible stainless steel tubing engineered and manufactured to get desired flexibility with greatest durability. Includes full description, construction, uses, etc., in illustrated Bulletin STC-1.
453B American Metal Hose Branch

Tubing.....Rugged, heavy-duty tubing for conducting corrosive liquids or gases. Available in six standard formulations to meet a wide range of chemicals and other operating conditions. Bulletin No. T-87.
104 U. S. Stoneware

Valves.....Beauty of functional design in continuously connected handwheel ...achieved by integrating parts in the compact, completely enclosed gear housing. Contains essential information in Bulletin No. 109-A.
6 Hammel-Dahl Co.

Valves.....Flowtrol valves designed to replace troublesome globe, angle, plug or gate valves that need frequent manual opening & closing at considerable waste of time & effort. Illustrated Bulletin No. W8-A.
453C Golden-Anderson Valve.

Valves.....Describes the wide range of types, sizes, pressures, and alloys available in line of stainless steel valves, with diagrams and dimensions. Includes description of alloys, data on selection, etc. Form 200
408 Jenkins Bros.

Valves.....Ultravalve design solves many of the new application problems presented by modern process control. Includes data on application, operational advantages, distinctive features, etc. Bulletin 103-A.
453D Hammel-Dahl Co.

Valves, Butterfly.....Illustrated, 23 p. provides data on line of O-ring butterfly valves. Includes features and advantages, uses and applications, special accessories, dimensions, O-ring information, prices, etc.
453E Mud Products.

Valves, Check.....Flanged silent check valves for the control of water hammer. Includes features, technical data & series of dimensional charts for valves of various sizes & pressure ratings. Bulletin WH-654.
453F Williams Gauge Co.

Valves, Control.....Explains design details and operating characteristics of the complete line of needle type valves. Engineered for applications requiring precise control of low rates of flow. Bulletin 5C-13.
453G Foxboro Co.

Valves, Diaphragm.....Diaphragm in packless valves does one job only—sealing bonnet. Independent disc does seating—saves wear & tear on diaphragm—permits closure of valve even should diaphragm fail.
271 Crane Co.

Valves, Float.....Covers line of float valves for more efficient liquid level and flow control. Simple in construction, rugged in service, accurate in operation, require less maintenance. Bulletin No. 101-B.
BR402 Davis Regulator Co.

Valves, Gate.....Exclusive precision-machined guides eliminate chatter ...lengthen service life in company line of iron body gate valves. Provides complete information concerning valves in Circular 564.
261 Lunkenheimer Co.

Valves, Gate.....Furnishes descriptive literature on fully revolving double disc, parallel seat gate valves... available in cast steel, iron body, rubber lined iron body, special alloys, and all bronze.
453H Darling Valve & Mfg. Co.

Valves, Gate.....Offers data on sturdy, small forged steel gate valves. Superhardened gate and seats assure tight closure, smooth operation and low maintenance. Find complete information in Catalog No. 10.
62 Chapman Valve Mfg. Co.

Valves, Line Blind.....Visible shut-off line blind valves offer many features: unsurpassed for positive action; easy operation; long-life service; lasting safety; etc. Data offered in descriptive Catalog.
329a Hamer Valves.

Valves, Plastic.....Plastic valves of unplasticized polyvinyl chloride described in a new Bulletin featuring both needle and globe valves. Needle valves range in size from ⅛"-¾"—globe valves from 1"-2".
453I Industrial Plastic Fab.

Valves, Porcelain.....Easy working and long life in chemical atmospheres... for company line of porcelain valves. Provides detailed Bulletin containing full description, characteristics and specifications.
82 Lapp Insulator Co.

Valves, Solenoid.....Announces a new line of cylinder operated solenoid pilot controlled valves for handling corrosive gases and liquids. Body material can be selected for particular fluid. Bulletin 8338.
453J Automatic Switch Co.

Valves, Solenoid.....Describes & illustrates additions to line of general service solenoid valves. Features include cast bronze construction, piston-pilot operation, full ports, etc. Illustrated Bulletin A-3.
453K J. D. Gould Co.

Valves, Solenoid.....Manual contains important general information such as detailed description & illustration of Shear-Seal principle & its application in manual & solenoid valves. Data in 34 p. Catalog No. 4G.
453L Barksdale Valves.

Electrical Equipment

Batteries, Storage, Industrial Truck..... 20 p. booklet furnishes electrical data, weights and dimensions of all standard battery assemblies for this service. Features of the nickel-iron-alkaline storage battery.
453M Edison Storage Battery Div.

Conduit, Wiring.....Offers full information on flexible, liquid-tight, electrical wiring conduit. Easy to install, economical to use...protects vital wiring circuits. Illustrated Bulletin No. UA-531.
365 American Metal Hose Branch.

Contactors, Air-Break.....Durability & long-term dependability were given prime consideration in the design. As result, the roughest repetitive duty becomes routine. Data in Bulletins 14B-6410B, 14B7303.
89 Allis-Chalmers Mfg. Co.

Drives, Fluid.....Available in nine different types, with a wide variety of input, output combinations for any motor or engine installations from ¾ to 850 horsepower. Covers full details in Bulletin No. 144-D.
L336 Twin Disc Clutch Co.

Motors.....Design of 2-pole motors 900 hp & larger described in new Bulletin. Ideal for boiler feed pumps, pipeline pumps, centrifugal blowers, descaling pumps, etc. Completely illustrated. 8 p. No. O5R8123.
453N Allis-Chalmers Mfg. Co.

Motors.....Enclosed motors meet tough requirements of chemical industry. Makes use of industry's latest materials including silicone, polyester film, Textolite and neoprene. Presents descriptive Bulletins.
71 General Elec. Co.

Motors.....The extra dependability of Electro Dynamic motors covered in new report, "Motor Showdown." Includes data on comparative results of motor performance tests. Also a Catalog of industrial motors.
335 General Dynamics Corp.

Motors.....Information on the new Life-Line "A" motors. Covers new insulating materials, new stator core, new cooling methods, new precision manufacturing techniques. Full details contained in Booklet B-6154.
30-1 Westinghouse Elec. Corp.

Motors.....Offer continuous trouble-free performance. Wide range of types & sizes in complete line permits selection of a standard motor for almost any need. Covers full details in Bulletin No. MU-185.
281 Wagner Elec. Corp.

Motors, Varidrive.....Get more production out of your present machines by powering them with Varidrive motors. Occupy little more space than single speed motor. ¼ to 50 hp, 2 to 10,000 rpm. 16 p.
L402 U. S. Elecl. Motors.

Reducers.....Motor reducers offer exclusive, superior features...for long range economy. "In-built" factors include: all-steel housings; wide speed range; streamlined inside & outside; etc. Bulletin 3104.
63 Falk Corp.

Switchgear.....Presents 24 p. guide to I-T-E high voltage switchgear. Covers features, switchgear components, applications, specifications, & construction data. Photographs & diagrams. Request Bulletin 7004 B.
453O I-T-E Circuit Breaker Co.

Transformers, Variable.....For processes that demand accurate adjustable voltage. Also feature the advantages of excellent regulation—high efficiency—cool operation—long life. Offers complete literature.
27 Superior Elec. Co.

Transmitters, Power.....Unequalled for repeated start-stop machine operation. Use of transmitters makes it possible to simplify machines, reduce costs, improve operation, etc. Details in Bulletin No. CE-3303.
79a Diehl Mfg. Co.

Mechanical Equipment

Bearings, Nylon.....Covers advantages of Nylon as a bearing material, particularly where bearings must operate without oil lubrication. Includes engineering & installation data in illustrated, 8 p. Catalog.
453P Thomson Industries.

Belts, V.....Announces publication of an entirely new edition of Catalog of rubber products for industry. Covers v-belts, transmission belts, all types of hose, molded products, etc. Illustrated. No. 25-C.
453Q Raybestos-Manhattan.

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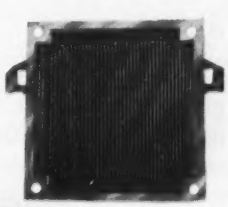
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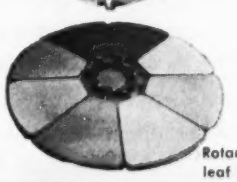
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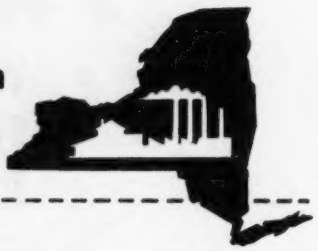

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LITERATURE . . .

Belts, V.....Links are quickly joined by easy-to-use cup-washers & T-screws to make up individual belts. Easiest V-belt to couple & uncouple. **Lasts** longer...more flexible. Offers new 8 p. illustrated Catalog.
77 Manheim Mfg. & Belting Co.

Casters & Wheels.....Provide maximum floor protection, economy and efficiency. Sturdy construction **offers** extra long life of satisfactory **service**. Types and sizes for every purpose. Full details in Manual.
R351 Darnell Corp.

Couplings, Automatic.....Automatic centrifugal clutch couplings feature an exceptional ability to handle all types of misalignment. Made in large number of sizes & several different types. Details in Bulletin CE-3.
454A Hilliard Corp.

Drives, Chain.....Announces the availability of a revised 16 p. profusely illustrated Catalog which includes new and expanded data on capacity ratings of Hy-Vo high speed, heavy-duty chain drives. No. C72-51.
454B Morse Chain Co.

Eliminators, Vibration.....Absorb vibration, deaden noise in air conditioning, refrigeration and other systems. Includes valuable data on features, installation, sizes, etc., in illustrated Bulletin No. VE-310R.
454C American Metal Hose Branch.

Packings.....Definite **savings** in maintenance costs...when you use spiral or die-molded ring packings. Means long uninterrupted sealing service with less wear on rods, shafts, sleeves or stems. File DMCE.
TR374 Durametallic Corp.

Packings, Lattice Braid.....Describes patented lattice braid rod & shaft packings. Points out construction features of lattice braid, & covers available materials, sizes, & forms. Illustrated Bulletin No. A-131.
462 Garlock Packing Co.

Turbines, Solid Wheel.....Feature reliable, trouble-free operation. Rugged construction & superior design result in savings by keeping maintenance costs to a minimum. Complete details in Bulletin S-116.
360 Terry Steam Turbine Co.

Heating & Cooling

Air Conditioning Units.....Full data on improved self-contained units with capacities from 3 to 20 tons. Line diagrams, wiring diagrams, capacity tables, examples of unit selection, etc. 24 p. Bulletin No. DS-362.
454D Trane Co.

Air Conditioning Units.....Heat-pumps are year-around air conditioning units which heat in the winter and cool in summer. Advantages, types, capacities, dimensions, etc., in illustrated Bulletin FT-50-A.
454E Acme Industries.

Looking for something?

You can bank on spotting it—and fast—in our new, master Index to Chemicals & Equipment in this issue. You'll find it a complete, finger-tip reference to this month's advertised items and new product developments.

Boilers, Steel Firetube.....Offers full information on Kewanee Reserve Plus Rating Plan in booket titled, "A Report to Those Concerned with the Specification, Selection, Sale of Steel Firetube Boilers."
455A Kewanee-Ross Corp.

Burners.....Completely illustrated Bulletin describes line of heavy-oil burners—belt driven horizontal rotary type. 7½ to 175 gal. capacity. Data on features, operation, specifications, etc. No. 175-H.
455B Preferred Utilities. Mfg.

Burners.....Thousands of burners, in chemical industries, have speeded up and improved many heating processes. 80 types and 800 sizes completely described and rated in detailed Catalog. Literature H54-16.
R406 Surface Combustion Corp.

Burners, Packaged, Forced Draft..... Built to specifications for Scotch Marine type boilers & other types of heat receivers designed for pressurized operations, for oil, gas or combination gas-oil firing. 6 p.
455C Ray Oil Burner Co.

Chillers, Water, Packaged.....Complete information, including capacity tables and roughing-in dimensions, on Cold Generators, the Trane line of packaged water chillers, available in new Bulletin No. DS-352.
455D Trane Co.

Chillers, Water, Packaged.....Correct selection of company line of packaged water chillers simplified by new detailed Bulletin. Covers features, general specifications, dimensional data, etc. No. 220.
455E Acme Industries.

Generators, Steam.....Reliable, safe & completely portable shop-assembled water tube boilers of extremely simple & compact design. Covers design & construction, capacities, dimensions, etc. Bulletin No. PSG-1.
455F Henry Vogt Mach. Co.

Heat Exchangers.....Experience in designing custom-built heat exchangers for all sorts of chemical and petroleum applications...helps to solve specific problems. Complete information on heat exchanger design.
99 Trane Co.

Heat Exchangers.....Details on brazed aluminum heat exchangers for difficult heat transfer applications requiring close temperature approaches, multistream exchange, or low temperatures. Illustrated.
BL347 Downingtown Iron Wks.

Heat Exchangers.....Offers complete descriptive material on the company line of Delanium graphite cubic heat exchangers. Valuable features: cubic design saves space; resist corrosion; reduce maintenance; etc.
43 Delanium Carbon Corp.

Heat Exchangers.....Particularly adapted to the handling of vegetable oils, fats, waxes, pastes, creams, etc. Obtain maximum production, maximum heat transfer, a better, more uniform product. Bulletin HE-100.
TL347 Davis Engrg. Corp.

Heat Exchangers.....Shows exactly how company line of plate heat exchangers are constructed and describes the vacuum-steam heating system for closest possible temperature control. Full details in Bulletin PHX.
50 De Laval Separator Co.

Heaters, Unit.....For steam or hot water applications. Offers a 48 p. illustrated Bulletin which includes the features of design, general engineering data, capacity tables, piping diagrams, etc. No. 7517.
455G American Blower Corp.

Heaters, Unit.....Describes line of high capacity blower-type unit heaters. Roughing-in dimensions, capacity tables & piping details provide handy reference for unit selection. Data in new Bulletin No. DS-327A.
455H Trane Co.

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Heating Systems, Steam.....Offers data on five major types of steam heating systems, with and without control, and a full line of valves, traps and steam power specialties. Details in 20 p. illustrated Bulletin 110.
456A American Air Filter Co.

Platecoils.....For tank heating and cooling problems due to inefficient pipe coils. These cost-saving Platecoils heat or cool 50% faster and take 50% less space in the tank. Details in Bulletin No. P61.
283 Tranter Mfg.

Tubes, Condenser.....Includes information on copper alloys, condenser tube corrosion, photomicrographs of grain structure of different metals under varying operating conditions, etc., in detailed, 28 p. booklet.
213 Revere Copper & Brass.

Tubes, Condenser.....With Trufin on the job...condensers & heat exchangers do a bigger job. Obtainable in copper (& its alloys), stainless steel, electric-welded steel, aluminum, bi-metal. New Trufin Book.
239 Wolverine Tube Div.

Handling & Packaging

Conveyors.....Provides detailed literature on company line of conveyors... which handle materials at great savings. Included are bulk chemicals, powders, abrasive dusts, sludges, etc. Data in Bulletin CE-954.
456B Hapman Conveyors.

Conveyors, Natural-Frequency.....Work on unique, patented vibrating principle which permits them to handle many materials too tough for most screw, belt, apron, vibrating, etc. conveyors. Data in Bulletin 111.
279 Carrier Conveyor Corp.

Conveyors, Screw.....Feature efficient operation plus long-life, low maintenance service. Company makes available a 92 p. screw conveyor book of pre-engineered selection and application data. Book No. 2289.
72 Link-Belt Co.

Drums.....Steel drums assure complete product protection. They are scale-free and rust-inhibited. Furnished in capacities from 2½ to 110 gallons. Presents complete data in full-color, illustrated Brochure.
41 U. S. Steel Products Div.

Feeders.....Pneumatically activated solution full-view plastic constructed pumps, with no metal surface exposed to liquids handled, permit accurate feeding of corrosive solutions. Offers detailed Bulletin 340.
87e Inflico Co.

Feeders.....Details on small, low-cost feeders for metering, controlling, mixing, and dispensing small quantities of liquid chemicals. Specifications, capacities, installation diagrams, etc. Catalog 70-50.
456C Fischer & Porter Co.

Feeders, Dry Chemical.....The simple operating principle of the Type E dry chemical feeders assures high accuracy...efficiency...and freedom from mechanical difficulties. Information in Bulletin 215-A.
875 Inflico Inc.

Feeder-Weigher-Conveyors..... Extremely accurate & durable weighing & feeding machines...for wide variety of industries. Use in cement & process industries, capacities, etc., in illustrated Bulletin 100-53.
456D Schaffer Poidometer Co.

Feeder-Weighers.....A self-contained, dust-tight, belt-feeding and weighing unit. Accuracy-indicating for process or intermittent batch weighing of lumpy, crushed, sluggish materials. Bulletin No. 1549.
52d Richardson Scale Co.

➔ Want more information on any of these items? Just circle its code number on the postcard inside the back cover, then mail to us. It's that easy now.

Feeder-Weighers.....Data on self-checking, automatic feeder-weighers for large tonnage; practically continuous stream delivery. Beam system has approval of all weighing authorities. Request Bulletin No. 2140-2.
52e Richardson Scale Co.

Formalin Handling.....Issues valuable Manual covering unloading, storing, temperature effects, safety precautions, tankcar construction, methods of analysis, first aid, properties, specifications. 1954 Edition.
277 Celanese Corp. of America.

Labelers.....For cans, bottles, jars & pails...assure neat, clean & tight label application. Accuracy is combined with speed & continuity of operation, resulting in important economies. Fully illustrated.
456E Standard-Knapp Div.

Lift Units, Fork Truck.....Enable the fork truck to lift a 2000 lb. load to 120" in only 23 seconds and to lift the empty forks to 130" in only 16 seconds. Request Twin-Lift Circular for complete details.
456F Lewis-Shepard Products.

Liquids Handling Equipment.....Features, advantages & specifications of full line of liquids handling equipment for petroleum, chemical, mine, railroad & construction industries. Illustrated Bulletin No. 63.
456G George D. Ellis & Sons.

Packaging.....Company presents upon request a new Brochure entitled "The Door to Better Packaging." It furnishes interesting details of the numerous tests used to maintain carton quality and economy.
456H Ball Bros. Co.

Packers, Bottle & Can.....Furnishing a smooth continuity of operation from processing equipment to shipping case ...packers load bottles or cans safely, quickly, and economically. Details in illustrated, 8 p.
456I Standard-Knapp Div.

Panels, Neoprene.....Solve flow stoppage problems and help reduce operating expense. Resistant to oils and most chemicals and are tough enough to withstand severe abrasive service. "Flow Stoppage Report."
330 Gerotor May Corp.

Pulleys, Magnetic.....Magnetic pulleys protect equipment in a coal preparation plant against bolts, spikes, cutter bits and other stray iron. Find complete information on pulleys in Bulletin No. C-5000-B.
98 Dings Magnetic Separator.

Racks, Hopper.....Describes and offers complete specifications on the new NesTier hopper rack. Versatile unit increases efficiency of small parts handling in assembly & production operations. Bulletin HR-101.
456J Chas. Wm. Doepke Mfg.

Ramps.....Describes & illustrates company's 40,000-lb. capacity hydraulic adjustable ramp engineered for lifting or lowering trucks while loading or unloading. Design, application, specifications, etc.
456K Rowe Methods.

Scales.....Bulletin offers data on a dust-tight, all-electric, high-speed, accuracy-indicating scale for weighing dry, ground, granular, dusty, non-free-flowing and some small lumpy materials. No. 3649.
52a Richardson Scale Co.

Scales.....Accommodate screw, belt, or vibrating feeder for handling wide range of materials. Dust-tight, solenoid- or motor-operated discharge, accuracy-indicating. Offers full details in Bulletin No. 1449.
52e Richardson Scale Co.

Separators, Magnetic Spout.....Drum-type magnetic spout separators eliminate tramp iron hazards. Remove destructive bolts, nails, tacks, etc. from your product—continuously, automatically. Bulletin No. 93-E.
68 Stearns Magnetic.

Trucks, Dragline.....New Circular covers Floormaster Dragline trucks for both in-floor and overhead conveyor lines. Construction data, engineering highlights, installation photos, specifications, etc. No. 29-A.
456L Lewis-Shepard Products.

Trucks, Fork Lift.....Supplies valuable information on company's new series of 2,000 3,000 and 4,000 pound industrial gas trucks with fluid coupling. Includes cost-saving advantages of new design features.
456M Yale & Towne Mfg. Co.

Trucks, Fork Lift.....Covers major construction and design features. Includes information on the steering and braking mechanisms, drive and control mechanisms, the hydraulic system, etc. Illustrated, 12 p.
456N Baker-Raulang Co.

Trucks, Industrial.....Electric industrial trucks in capacities ranging from 1,000 to 100,000 pounds are described & illustrated in new booklet. Includes data on performance & engineering characteristics.
456O Yale & Towne Mfg. Co.

Trucks, Pallet.....Company supplies descriptive literature covering their line of narrow aisle, rider-type electric low lift pallet trucks with eight load wheels, arranged in dual, tandem fashion. Illustrated.
456P Raymond Corp.

Vibrating Equipment.....230 p. profusely illustrated & detailed Catalog on complete line of feeders, conveyors, coolers, dryers, mixers, constant weight feeders, bin check valves, packers, screens, etc. No. 870.
456Q Jeffrey Mfg. Co.

Wrapping & Bundling.....Covers numerous subjects: "What is Wrapping & Bundling;" "Classification of Wrapping Methods;" "Types of Wrapping Materials;" "Selection of the Right Machine." Bulletin 25.
456R Paisley Products

Processes, Services, Misc.

Ammonia Process.....Describes advantages of Kellogg ammonia process... which finds new ways to higher yields, bigger profits, less down time. Request "High Yields, Low Operating Cost Through Ammonia Plants."
456S W. M. Kellogg Co.

Aprons & Protective Apparel.....Lists all such items manufactured by company & includes actual swatches of materials in which they are available with type of service for which each material is best suited.
456T Surety Rubber Co.

Cathodic Protection.....Institute makes available pertinent details on zinc for cathodic protection and grounding electrodes, in their descriptive booklet entitled, "Cathodic Protection with Zinc Anodes."
324a American Zinc Institute.

Chemical, Plastics, Fertilizer Industries.....Second number in the series, "Technology Behind Investment," contains 3 reviews of trends and prospects for growth in chemical, plastics, and fertilizer industries.
456U ..... **Arthur D. Little.**

Design & Construction.....Fabrication of vessels, agitators or precision machinery...to engineering, design & construction of process units or entire industrial chemical plants. Offers detailed Bulletins.
355l Industrial Process Engrs.

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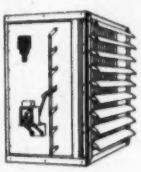

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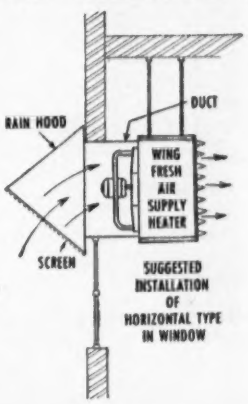

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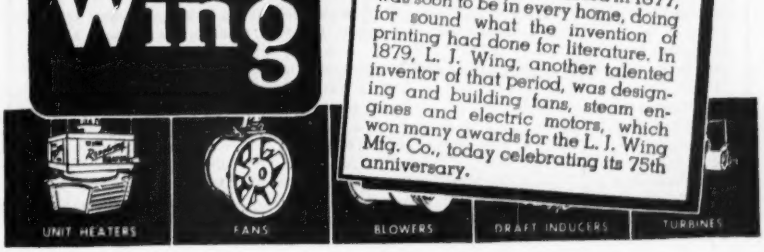

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You can use this index to spot quickly what advertisers are in this issue and the page location of their ads. You can get more information on the products advertised by any of these companies by circling the page number (code) on the Reader Service postcard inside the back cover. When more than one product is advertised, refer to the alphabetical listing in the Index to Chemicals and Equipment for the code number of the specific product in which you're interested.

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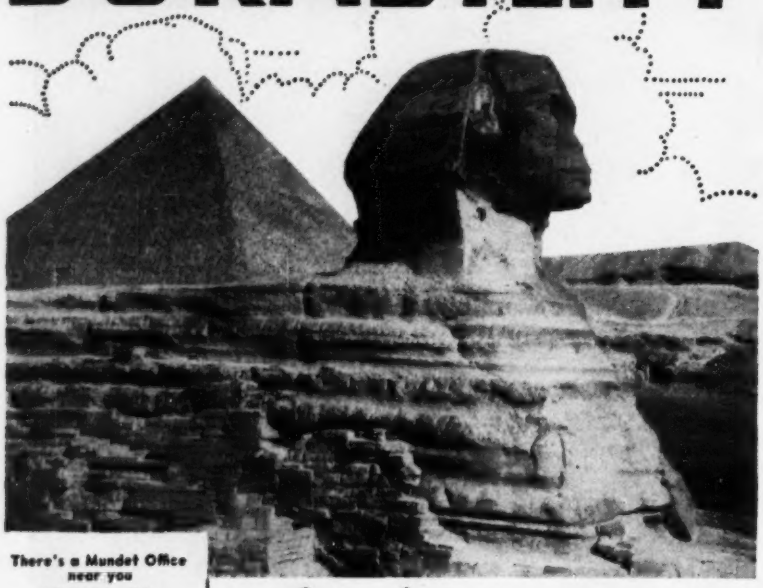

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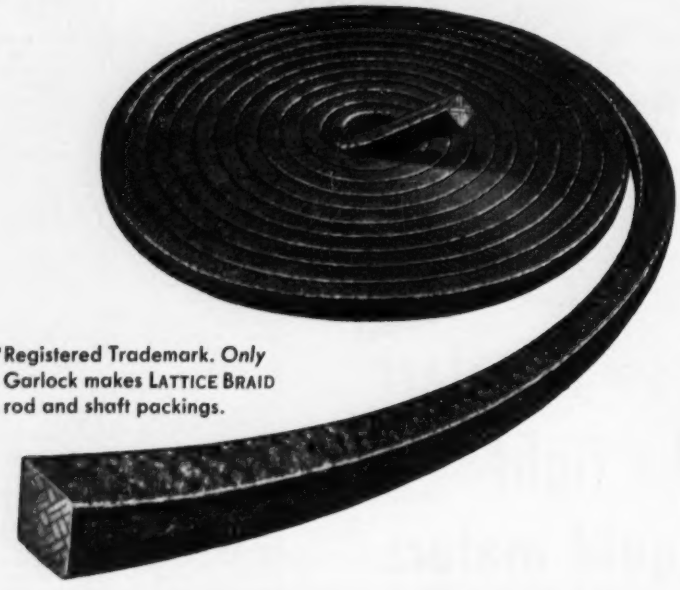

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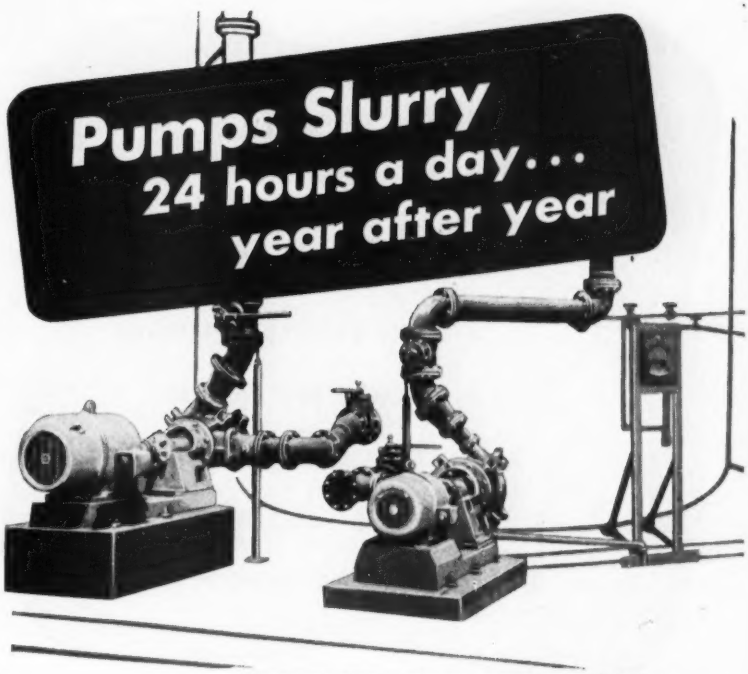

● MORRIS TYPE R SLURRY PUMP at the left is on continuous 24-hr. duty delivering 1000 GPM of a 170° lime slurry at 100′ head. Fifty-HP motor operates at 1180 RPM. Intermittent-duty pump at right delivers 200 GPM at 50′ head with 7½-HP motor turning at 880 RPM.

In slurry-handling operations, "long-term service" is a meaningless claim unless the pump will work day-in and day-out with a minimum of maintenance time, trouble and expense

Morris Type R Slurry Pumps—with an established reputation for longer life—also incorporate in their design exclusive features which result in easier installation . . . fewer interruptions to service...less overhaul...fewer replacements.

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Impeller removed without disturbing the piping. You simply loosen 4 *outside* clamping bolts and pull off the end cover. This feature alone saves considerable time and labor.

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17	53c	75a	111b	152C	247b	278B	310a	R345	366	399	444B	446L	452C	456K
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18–9b	53e	76	111d	153	247d	278D	311	TL347	368	L402	444D	446N	453	456M
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44	69	95	133	225	272C	290	333							

142A	146C	148C	150B	150E	268A	270A	270D	272B	274B	276A	280A	280D	282C	284C
144A	146D	148D	150C	150F	268B	270B	270E	272C	274C	278A	280B	282A	284A	284D
146A	148A	150A	150D	266A	268C	270C	272A	274A	274D	278B	280C	282B	284B	284E
146B	148B													

1	2	3	4	15	17	21	22	25	26	27	28	29	33	34	35	36
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36	37	38	40	41	42	43	44	45	46	47	48	49	50	52	53	54
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Did You Miss Anything?

If you did, you'd better look again at this issue of Chemical Engineering. Maybe you missed a good bet. Did you see these articles:

Binary Distillation *Aaron J. Teller* ..... **page 168**

Let's Look at Selective Adsorption *George Karnofsky* **189**

How to Use Shortcut Statistics *F. Proschan & A. B. Babcock, Jr* **193**

Valves to Combat Corrosion **198**

Get Rid of Fouling in Ion Exchangers *F. X. McGarvey & A. C. Reents* **205**

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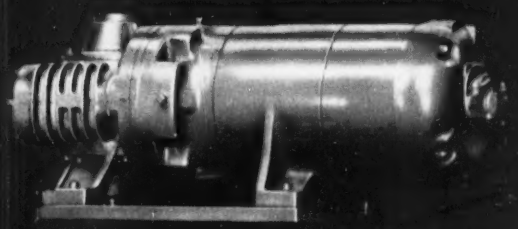

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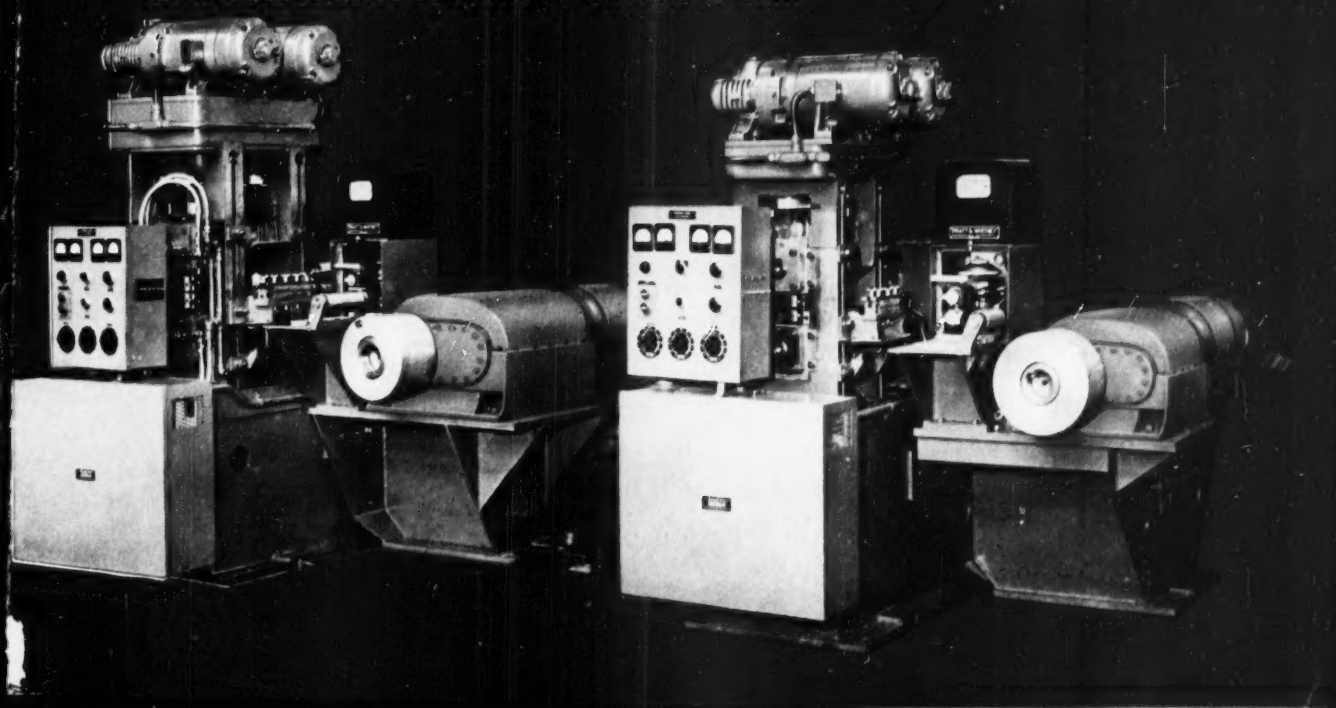


Corrosioneering News

Quick facts about the services and equipment Pfaudler offers to help you reduce corrosion and processing cost.

Published by The Pfaudler Co., Rochester, N. Y.

Pfaudler Acid-alkali-resistant Glass Now Standard on Glassed Steel Units for Severe Chemical Service

Both of these glassed steel discs were exposed to buffered caustic soda (pH 11.5) at 212°F. for 30 days. Acid-alkali-resistant glass (above) was unaffected.

Above, note how the high-quality glass which was formerly used in Pfaudler glassed steel vessels was severely etched.

On September 1, 1954, acid-alkali-resistant glass became standard for all Pfaudler glassed steel equipment for severe chemical service. This new glass was first introduced to the chemical industries in November, 1951, and has been available as "special" since then.

Almost universal corrosion resistance

Wide and varied field experience over the past three years fully verified the original expectations for this glass—it has acid resistance equal to or better than the previous standard glass and, in addition, it is *three times as resistant* to corrosion by alkaline solutions.

Specifically, this glass is resistant to corrosion by all acids (except hydrofluoric), even at elevated temperatures and pressures, and to alkaline solutions up to pH 12 and 212°F.

10% price reduction

As "special," acid-alkali-resistant glass carried a 10% premium charge over the former standard glass. Now as a standard, this premium is eliminated and it will be available at no increase in price.

Acid-alkali-resistant glass, like the former standard, is deep blue in color. To permit identification, there is a glass number on the name plate of every Pfaudler vessel. At present, the number "53" is being used to designate the new standard glass while the number "42" designates the former standard. A new numbering system for easier identification is now in process. Full details will be included in a later issue of "Corrosioneering News."

Field experience "proves in" acid-alkali-resistant glass

A 1,000-gallon oxidation kettle, lined with acid-alkali-resistant glass, was placed in use 3½ years ago, processing sodium hypochlorite bleach containing 12-15% free chlorine. It produced 3,694 batches before showing noticeable wear. This is more than three times as many batches as were possible with regular high-grade Pfaudler glass.

"WORKHORSE"

Heat Exchanger Solves Cleaning, Gasket Problems

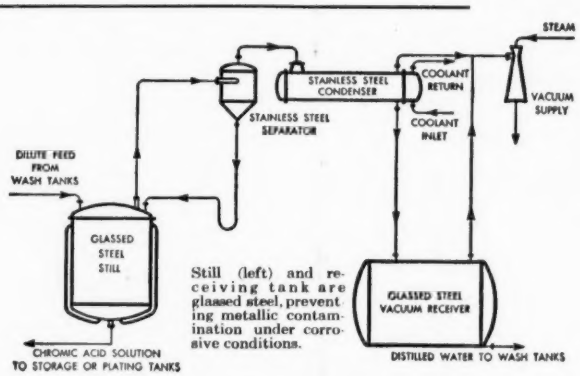
The nonremovable tube bundle of Pfaudler's Type FTS (fixed tube sheet) heat exchanger has won friends throughout the chemical processing industries. A money-saver, it simplifies cleaning and eliminates gasket problems.

The shell is permanently welded to the tube sheets, doing away with *all* gaskets or packed joints on shell side. There are *no* internal gaskets—no possibility of leakage or intermixture of hot and cold fluids.

Low First Cost

Original cost of Type FTS heat exchanger is low, because of its simple construction and standard design. Upkeep is low, because tubes are easy to clean, and you eliminate the problem of replacing gaskets or purchasing costly special gasket materials.

For complete data on this cost-cutting "workhorse," write for Bulletin 837.



Still (left) and receiving tank are glassed steel, preventing metallic contamination under corrosive conditions.

Packaged system recovers chromic acid

In plating operations, you can get substantial savings by the recovery of chromic acid from waste rinse water.

You do this easily with a Pfaudler chromic acid recovery system—a standard "packaged" system designed and fabricated by Pfaudler process engineers.

The system simply evaporates some of the waste wash water returning the balance to plating strength. This is then piped back to the plating tank. The distilled water obtained by the evaporation process is reused as pure wash water.

The Pfaudler system makes use of stainless steel for contact with pure water, while glassed steel protects equipment which must resist direct attack by the hot 24% to 45% chromic acid solution. Field experience and laboratory tests have both proven conclusively that acid-resistant glassed steel is the only practical material to withstand this attack.

Standard chromic acid recovery systems are available in capacities of 200, 300, 500 and 1,000 gallons. Often these systems pay for themselves within six months. One midwestern plant saved $42,000 a year by installing a Pfaudler system.

Write for Bulletin 914, which describes these systems in detail.